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Possible effects of the Department of Defense acting as a buyer on the derivatives futures market

Bowman, Thomas R.

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NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

MBA PROFESSIONAL REPORT

Possible Effects of the Department of Defense Acting as a Buyer on the Derivatives Futures Market

By: Thomas R. Bowman
Evan P. Wright
June 2009

Advisors: Douglas Brook
Nayantara Hensel
Donald Summers

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The purpose of our professional project is to research the possible effects of the Department of Defense's (DoD) participation as a buyer in the commercial futures market for derivatives.

The idea that DoD should participate in derivatives trading has been proposed and published by others in the past; however, the recommendations we reviewed failed to provide empirical evidence to highlight likely outcomes if their recommendations were put into practice. With this project, we research the likely effects that DoD purchases of oil on the commercial futures market would have on the market price. Additionally, we research to determine how substantial DoD savings or losses could be from practicing a hedging program. We take a mostly quantitative approach to investigate our questions, then integrate qualitative analysis to support our final conclusions and recommendations.

The goal of this project is to achieve federal government recognition and consideration of our findings. We believe that hedging against the rising costs of fossil fuels in the commercial futures market is a terrific, low-risk action that DoD could practice in fuel procurement.

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POSSIBLE EFFECTS OF THE DEPARTMENT OF DEFENSE ACTING AS A BUYER ON THE DERIVATIVES FUTURES MARKET

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MASTER OF BUSINESS ADMINISTRATION

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POSSIBLE EFFECTS OF THE DEPARTMENT OF DEFENSE ACTING AS A BUYER ON THE DERIVATIVES FUTURES MARKET

ABSTRACT

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LIST OF ACRONYMS AND ABBREVIATIONS

ABC	Activity-Based Costing
BBL(s)	Barrel
CFTC	Commodity Futures Trading Commission
CY	Calendar year
DESC	Defense Energy Support Center
DFSC	Defense Fuel Supply Center
DLA	Defense Logistics Agency
DoD	Department of Defense
DoE	Department of Energy
EIA	Energy Information Administration
FY	Fiscal Year
FYDP	Future Year Defense Plan
GAO	Government Accountability Office
IDIQ	Indefinite Delivery/Indefinite Quantity
IMM	Integrated Material Manager
INCONUS	Continental United States
MMBTU	Million British Thermal Units
MB/D	Million barrels per day
NYMEX	New York Mercantile Exchange
OMB	Office of Management and Budget
PED(s)	Price Elasticity of Demand
PPI	Producer Price Index
U.S.	United States

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We would like to thank everyone who has provided us with guidance, information, opinions and ideas in this endeavor. We especially thank the following people for making significant contributions to this project:

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- Dr. Nayantara Hensel for agreeing to stay on this project as a technical advisor even though she moved cross country for a larger position. Her support was critical in ensuring our methods were in line with the science of economics.
- Mr. Donald Summers for agreeing to act as a Second Reader in this project. His insight and questions helped to ensure this was a professional product in the end.

Lastly, we thank the various staff members at the Defense Energy Support Center, and the office at the Under Secretary of Defense (Comptroller) for providing us with information and data in support of this project. Without their support, we would not have been as successful in conducting this study.

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I. INTRODUCTION

A. PROBLEM IDENTIFICATION

In recent fiscal years, the Department of Defense (DoD) has had to find ways to overcome budget issues caused by the rising costs of fossil fuels. For example, in 2008 alone, fuel prices were 300 percent higher than they were just six years ago, according to Roger Lowenstein (MM46). To meet this unplanned burden, Tom Meredith with the Office of the Under Secretary of Defense (Comptroller), writes that during Fiscal Year (FY) 2008, Congress had to appropriate to DoD an additional $4.2 billion so that it could pay for fuel (1). FY2008 is not the only year that fuel-price volatility has caused financial pain for DoD, and future oil-price uncertainties could bring more of the same. To what degree is anyone's guess. Herein lies the problem for DoD—the future cost of fuel is all but impossible to forecast accurately for budget purposes. How does DoD deal with this problem? For instance, should the Department stop procuring capital hardware just to have enough cash available to cover higher fuel costs in the future? This is not a good option, as DoD must make large capital investments now in order to maintain primacy in the future. The Department must make changes to the way it currently procures fuel and must fully consider every available option which will assist in this endeavor.

The National Defense Industrial Association reports that DoD consumes around 1.8 percent of the country's total transportation fuel requirements, which makes it the largest single user of fuel in the United States (1). Around 2 percent of DoD's entire annual fiscal budget is devoted to fuel costs. When fuel costs unpredictably rise to seemingly infinite levels as witnessed during FY2008, DoD pays for this fuel regardless of the costs. Information provided in a briefing slide from the office of the Under Secretary of Defense (Comptroller) estimates that an increase in the yearly average cost of a barrel (bbl) of oil of just $1 increases DoD baseline operations costs by $130 million (1). Whether current or future budget, DoD pays this additional cost at a significant expense.

Not all DoD Departments suffer equally when fuel costs rise. Figure 1 shows graphically, that during FY2008, the Air Force was DoD's largest fuel user followed by the Navy, then the Army. This is a consistent pattern across past FYs. As a result, the Air Force tends to feel more budgetary pain during times of increasing fuel prices. To deal with unforeseen increases, other programs within a budget tend to get reduced or cut all together to supplement the fuel expense deficit. For example, Matt Branch writes that "historically, the Air Force funds unexpected expenses with an undistributed reduction across all programs, delaying the development and production of critical war fighting systems" (qtd. in Spinetta 1). Responses such as this to budgetary shortfalls caused by fuel expenses, ultimately affect future military readiness and procurement. Specifically, in writing about how the Air Force narrowly escaped unfunded FY2006 fuel costs, Air Force Logistician Lawrence Spinetta states:

> The Pentagon's comptroller allocated $1.1 [billion] in new Air Force funding, mostly to cover fuel costs, but slashed $4 [billion] in nonfuel programs from the Army, Navy and Marine Corps budgets. Although PBD [Program Budget Directive] 723 was favorable from an Air Force perspective, it was far from ideal. It delayed the Airborne Laser Program and cut $100 [million] from the Joint Strike Fighter engine account. (1)

This is just one example of many from FY2006. Both the Army and Navy lost funding for procurement programs through the sweeping action of PBD 723.

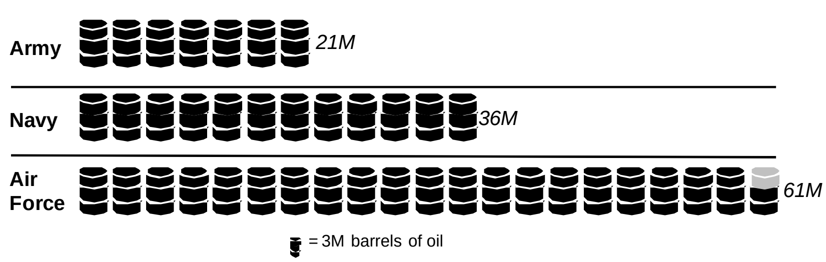


Figure 1. DoD Fuel Usage by Department. (From briefing slide, Under Secretary of Defense [Comptroller])

In consideration of alternatives to current fuel procurement methods, the Federal Government has examined the possibility of hedging against fuel costs by participating in the commercial futures market for derivatives. In 2003, the Office of Management and Budget (OMB) recommended that DoD engage in a pilot program to hedge against volatile fuel costs. DoD was not directed to do so, but only recommended to consider such a program. In response, Denis Bovin writes that DoD claimed such a program would provide little cost benefit and the savings would not be significant enough to justify implementation (Bovin 6). This response was officially provided even though the successes realized by the American commercial-airline industry served as examples for how hedging through the futures market helps in saving significant amounts of money on fuel purchases over time. Airlines practice such strategy in order to offer low fares to customers while hoping to make a profit. DoD's goal would not be to generate profit, but rather to aid in budget planning and saving tax-payer dollars.

B. PROJECT DESCRIPTION

In an attempt to identify a risk-reduction option for DoD's fuel costs, this study explores whether DoD could hedge against such risks by making purchases on the commercial futures market for oil without causing any significant disruptions to the market. The disruption we are primarily concerned with is whether DoD purchases on the futures market would have a price increasing effect on the per bbl price for oil. Additionally, we are interested in identifying how substantial DoD savings or losses could be from practicing a hedging program. We take a mostly quantitative approach to investigate our questions then integrate qualitative analysis to support our final conclusions and recommendations.

The project is structured to examine the various considerations associated with DoD fuel procurement/payment and the commercial derivatives trading market. Chapter II provides background concerning:

- How DoD purchases fuel
- The history of DoD fuel-procurement entities
- DoD fuel contracting procedures
- How DoD arrives at a stabilized price to charge its fuel customers

- How the Defense Working Capital Fund is involved in the process
- Reasons for oil price volatility

Chapter III explains hedging, the futures market, the American commercial-airline industry's hedging practices and lastly, reasons why DoD does not currently practice a hedging strategy. Chapter IV presents the methods and results of our quantitative analysis. Finally, Chapter V presents our conclusions and suggests further analysis and recommendations.

This project is important for identification of an alternative fuel procurement strategy for DoD. We expect this project to be of value to those in government positions interested in the idea of government hedging and to provide policy makers with empirical evidence needed to move forward with a hedging program for DoD.

II. BACKGROUND INFORMATION

A. CHAPTER OVERVIEW

This chapter provides background information on the following topics: DoD fuel purchasing processes, the history of the Defense Energy Support Center (DESC), DoD fuel contracting procedures, and the establishment of stabilized fuel prices. Additionally, the concept of the Defense Working Capital Fund (DWCF) and a discussion of reasons why market prices for fuel experience great volatility are presented. An understanding of the above-listed topics is critical in order to understand our research methodology and the unique problems suffered by DoD in the face of volatile fuel prices.

Throughout this chapter, the reader will better understand that DoD is a unique organization that does not operate as a traditional, commercial enterprise. Due to the nature of its business activities, which is defense of the United States, fossil fuel usage is a necessity for daily worldwide operations. Therefore, fuel costs are an issue of great concern for DoD managers. This chapter provides a foundation of information for the reader to cultivate his or her own thoughts concerning the issues we present throughout this project.

B. HOW DOD PURCHASES FUEL

1. Overview

DoD makes its refined fuel purchases in a two-step process under the direction of the Defense Logistics Agency (DLA) and the individual service or agency customer. The DLA, through its DESC, which funds its operations through the DWCF, purchases fuel products in bulk, and subsequently sells the fossil fuel products to individual DoD customers. This method of fuel distribution is beneficial to DoD for two reasons. First, it allows DoD to take advantage of economies of scale by purchasing large quantities of fuel at the lowest possible prices. For example, DoD realizes savings in transportation costs associated with moving the fuel from point-to-point when fuel is purchased in large quantities. The second reason is that individual customers serviced by DESC gain an advantage in planning fiscal budgets for fuel based upon a stabilized fuel price (discussed further in subsection 3), which normally remains static throughout a FY. However, this advantage has been recently eroded by the drastic increases of fuel prices in the market. Some of the reasons why fuel prices can change so drastically are discussed in more detail later in this chapter under Section E.

In this section we provide a brief background and history of DESC as well as explore DESC's standard contracting procedures.

2. The History of the Defense Energy Support Center

In order to fully appreciate the challenges and concerns that the U.S. military has regarding fuel procurement, distribution, and usage, it is important to first have a fundamental understanding of the entity that controls fuel supplies for DoD. DESC, located in Fort Belvoir, Virginia, was created as a result of the fuel logistic needs identified during World War II. Established as a component of the Department of Interior, DESC was originally known as the Army-Navy Petroleum Board. The primary mission of the board was to provide the critical petroleum requirements to our combat forces during World War II. In 1945, control for meeting fuel demands of the Armed Forces was transferred to the War Department, and the Army-Navy Petroleum Board subsequently became the Joint Army-Navy Purchasing Agency. In 1962, the Agency became part of the consolidated military supply organization, the Defense Supply Agency, now known as the Defense Logistics Agency. In 1964, the Center was designated the Defense Fuel Supply Center (DFSC) and was the sole entity responsible for purchasing and managing the Department of Defense's petroleum requirements ("Defense Energy Support Center").

By 1973, DFSC had progressed from focusing primarily on wholesale fuel procurement to adopting a more aggressive mission by assuming the responsibilities as the Integrated Material Manager (IMM) for DoD petroleum requirements. The experts at DESC outline the transitional phases which support the IMM mission:

> Under Phase I, DFSC added management of the acquisition, storage, distribution, and sale of fuel with responsibility ending at the Service installation boundary. In 1991 Phase II began, which expanded DLA's ownership of bulk petroleum products to include most bulk storage installations. This effort was divided into two parts, Phase IIA which capitalized aviation fuel and Phase IIB which will capitalize all ground fuels. Once Phase II is completed DLA will own all bulk petroleum products from the point of purchase until its final point of issue to power aircraft, ships, and ground equipment. ("Defense Energy Support Center")

On February 11, 1998, the Center changed its name to the Defense Energy Support Center. From that point, DESC began to execute its new mission of building an energy program that was directed towards moving DoD away from the management of energy infrastructure and into the management of energy products. Today, DESC's mission remains critical: to support the warfighter by managing, purchasing, and satisfying the requirements for all of the petroleum resources used by the U.S. military.

3. DESC's Contracting Procedures

Fuel procurement is the responsibility of DESC, and it only procures refined fuel products through a competitive process. Competition for various fuel contracts generally involves DESC putting the contract out for bid, receiving bids, and then using those prices in conjunction with other important evaluation criteria (delivery, reliability, and so on) on a points system in order to choose which private contractor will be awarded the contract. Unless otherwise noted, all contracts are "fixed price with economic price adjustment" contracts. Economic price adjustment contracts allow vendors to be compensated if the prices to their inputs increase. In the article "The U.S. Military's March 2009 Fuel Contracts," an example of an economic price adjustment contract is described:

> For instance, the government signs an oil contract with Company A at a fixed price, but with economic price adjustment. If oil prices later go through the roof, Company A doesn't have to go bankrupt supplying that oil because there's an agreed formula under which the government will pay extra as a function of the rise in commodity prices. ("Spotlight: The U.S. Military's March 2009 Fuel Contracts")

Contracts that allow for economic-price adjustment have become essential to the government's ability to procure fuel for two reasons: (1) if DESC did not do this, firms would pad their bids to cover for likely price-fluctuation risks; and (2) many companies would be far less willing to bid for long-term, government-fuel contracts because of the high risks associated with such extremely large contracts. Without economic-price-adjustment contracts a security of supply issue for DoD would be created, which would have potential to reduce the overall number of bidders and essentially eliminate small-business bidders completely from this market. With a structural lack of competition, the result would be higher prices as well as higher risk premiums ("Spotlight: The U.S. Military's March 2009 Fuel Contracts").

Most of DESC's contracts are listed as Indefinite Delivery/Indefinite Quantity (IDIQ). With IDIQ contracts, fuel is purchased as needed in appropriate quantities up to the limit of available funds from commercial suppliers. The article "The U.S. Military's March 2009 Fuel Contracts" provides an example of a typical DESC issued contract:

> March 24/09: Equilon Enterprises in Houston, TX won a maximum $1.51 billion fixed-price with economic price adjustment, IDIQ contract for fuel, to supply the Defense Energy Support Center. There were originally 68 proposals web-solicited, with 26 responses. The contract will run until Apr 30/10. ("Spotlight: The U.S. Military's March 2009 Fuel Contracts")

In the article, "Military Needs Efficient Fuel-Buying Process," the fuel contracts that DESC negotiates are further explained:

> Solicitations are issued and awards are made based upon the lowest bid. The DESC bid evaluation model, which determines the lowest overall cost of product to the government, takes into account the product, additives, distribution costs, quantities offered, transportation, storage, terminal throughput constraints and minimum quantity requirements.
>
> Fuel is purchased using four different contract mechanisms – bulk, into-plane, bunker and post-camp-station contracts. Bulk contracts account for approximately three-fourths of the fuel supplied by DESC. The fuel is transported by pipeline, barge, tank truck, railcar, or a combination of these. (22)

Each branch of the military is responsible for managing its respective fuel requirements purchased through DESC. The Army covers ground fuels, the Navy handles both shipboard and aircraft fuels, and the Air Force manages aircraft fuels. In general, military specifications differ from commercial specifications. DESC procures refined-fuel products because of the unique fuel-requirement demands of the military. Some of the unique needs include: increased storage stability, additives, a wider operating temperature range, and improved survivability from fires. These requirements are driven by the weapons systems and platforms that consume the fuel as well as the geographical areas where the systems are deployed or intended to be operated.

Generally, DESC contracts come in all shapes and sizes and last for at least one year in duration. DESC takes offers on all fuel contracts from private companies that are willing to meet the fuel specifications and the demand quantities that DESC has received from each individual service customer. DESC awards the contracts to the company that best fits both the needs of DESC and the end user, the warfighter. Private companies fulfilling DoD contracts will typically pay the going market price for crude oil and then add to this base cost, the expenses incurred to refine, transport, store, and deliver the fuel to DESC acceptance points. The price charged to DESC by the contractors is measured in per-gallon units. In-depth analysis and linear programs help contract-interested companies conduct cost-benefit analysis to assist in establishing a competitive price that is both profitable for the company and cheap enough so that they may be awarded fuel contracts from DESC. The corporate strategies of the individual suppliers fulfilling contracts to DESC provide guidance as to how they procure fuel and as to if they take any risk-mitigating steps such as participation in the futures markets. Such strategies could potentially allow suppliers to provide fuel at a cheaper price. Profit margins for commercial vendors are typically small and they receive payments for fuel on a weekly or monthly basis, based on movements of the constantly fluctuating oil market.

DESC is the main consolidation hub for the fuel purchases inside the Continental United States (INCONUS). However, to supply overseas, in-theater fuel requirements, DESC works with local companies and refineries to acquire fuel and transport it directly to the end-user. Purchasing fuel in theater cuts down on transportation costs and allows for quicker delivery of fuel to the warfighter.

Even though DoD makes its fuel purchases in gallons, the Department tracks purchases/usage in bbls. Meredith reports that this is done in order to align with NYMEX and other federal entities such as OMB and DoE, which practice this method of record keeping. Furthermore, for simplicity sake, it is much easier to compute dollar figures when oil units are in bbls. For example, in FY2008, DoD customers purchased 119 million bbls of fuel. Reporting this figure in bbls is much simpler and less confusing than stating the customers purchased 4,998,000,000 gallons.

C. DOD PROCESS FOR ESTABLISHING STABILIZED FUEL PRICE

1. Overview

DoD's fuel cost problems are compounded by the overall Federal budget process. When DoD purchases fuel, it does so at the spot-market price at the time of purchase, but DoD begins to build its FY budget approximately eighteen months in advance. Early budget construction requires a forecasted, stable price for fuel upon which to base the monetary request to Congress. The component services use the stabilized price in conjunction with their estimated fuel requirements based upon activity levels such as steaming days, flying hours, and miles to travel. The stabilized price set in one FY traditionally remains unchanged until the subsequent FY. However, during FY2005, DoD began changing the stabilized price as needed in order to reflect fuel cost reality. This price-forecasting procedure is the beginning of DoD's problems that arise from volatile oil prices.

This section explores DoD's process for arriving at a stabilized price by reviewing the individual components that make up a delivered barrel of fossil fuel. Additionally, the current method for forecasting, as well as some of the alternative methods that DoD could use, are discussed in relation to how fuel-price forecasting further complicates fuel cost budgeting.

2. Concept

Forecasting fuel prices is difficult at best. The current method used by DoD provides an estimate that is consistently lower than the actual market price paid by DoD in its acquisition of fuel. For example, Sharon Pickup reported in a Government Accountability Office (GAO) document to Congress that the Office of Management and Budget (OMB) oil price forecasts were, on average, \$11.83 lower than the actual market price paid for a bbl of oil from quarter four, FY2005 through quarter one, FY2007. Additionally, Amy Butler reports that in FY2005, “the Pentagon’s forecast was so inaccurate that it had to set a revised oil price that was 50 percent higher than the original price” (1). These inaccuracies in forecasting are problematic because DoD has no choice, but to consume fossil fuels to operate in support of its mission. The costs for the fuel required by the military must be paid or the military cannot operate. Congress is responsible for approving and appropriating funding to the military. Therefore, when DoD experiences a budget short fall due to higher than expected fuel expenses, Congress is the organization within government that must move quickly to authorize additional funding for fuel expenses. In meeting this challenge, Congress has the option to appropriate new funding or authorize the transfer of funds from already existing appropriations to make up for funding shortfalls. Figure 2 provides a graphical depiction of the variation between OMB forecasts and actual market price.

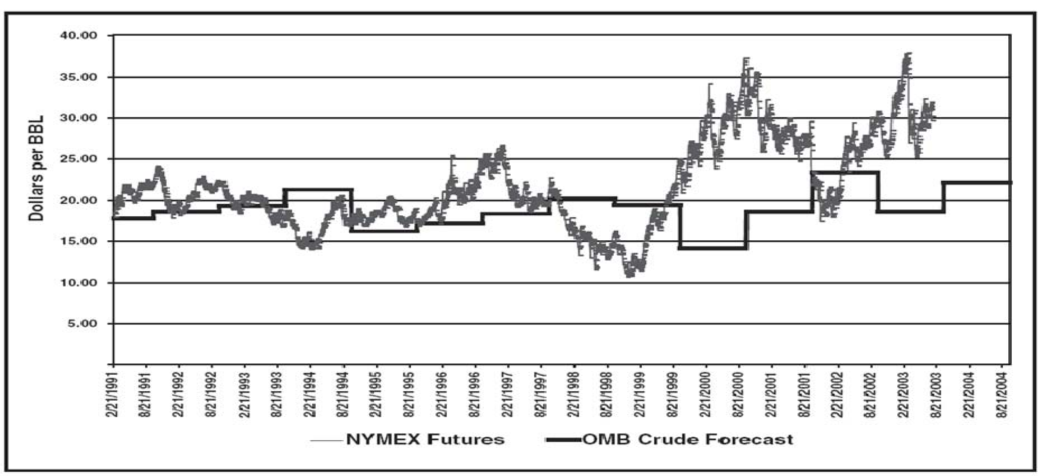
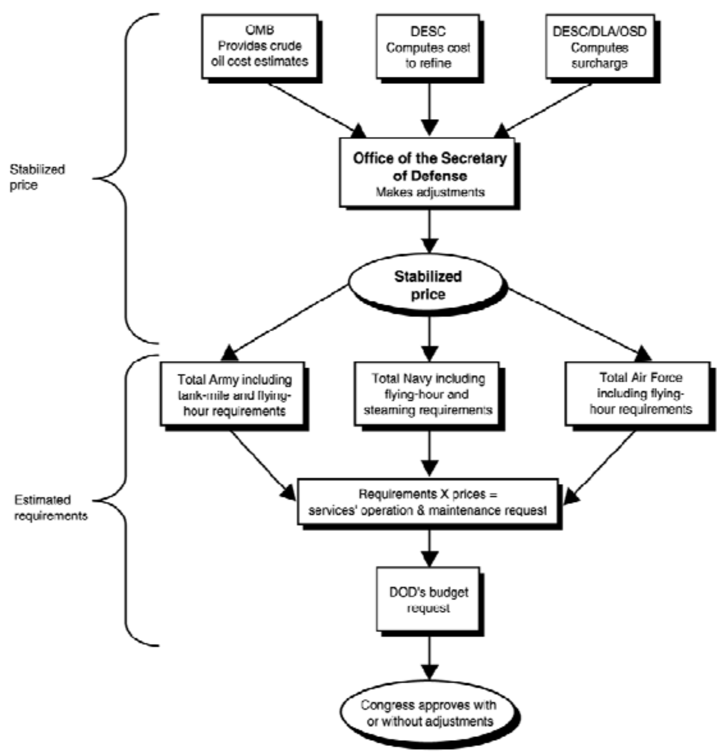


Figure 2. Actual Crude Oil Prices Compared with OMB Forecasts, February 1991 to August 2004. (From Spinneta 36)

DoD uses crude oil price forecasts calculated by OMB to determine its budgeted fuel costs each FY. The forecasted price provided is a base figure that represents only the expected market price for a bbl of oil. DoD takes this base figure and establishes a stable price which is used by all component services within DoD to calculate budget requirements for fuel. To arrive at the stable price, DoD considers two other figures in addition to OMB's base forecast. First, the expense associated with refining the oil to a useable fuel is added and secondly, a surcharge representing the overhead expenses DoD incurs in providing fuel to its customers is added to arrive at one, consolidated-stable price for a bbl of fuel. Since there are forty-two gallons in a barrel, the stable price per barrel is divided by forty-two in order to calculate the price per gallon that DoD customers will pay for various types of fuel. Figure 3 provides a flow chart depiction of DoD's process for setting the stabilized price.



Legend:
DESC Defense Energy Support Center
OMB Office of Management and Budget
OSD Office of the Secretary of Defense

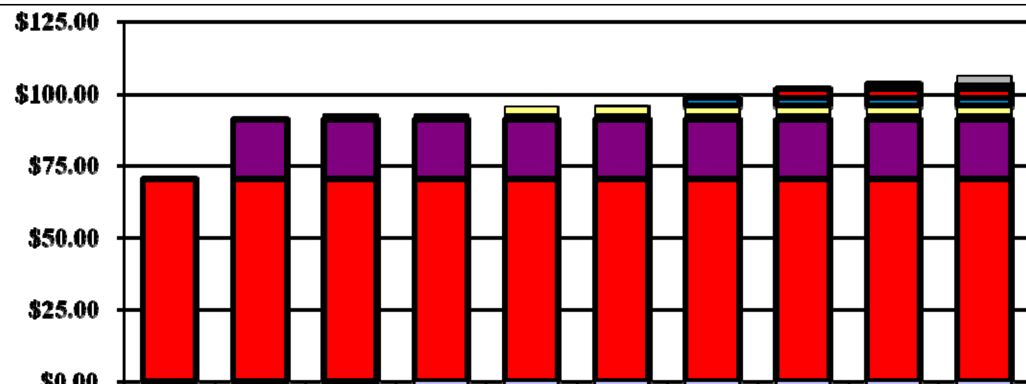
Figure 3. DoD Budget Process for Fuel. (From Warren and Kutz 6)

The first step DoD takes in calculating a stable price is to start with the OMB forecast. This forecast is an amalgamation of inputs provided by the Department of the Treasury, the President's Council of Economic Advisors, and OMB. Collectively, these three entities are known as the "Troika" within the Executive Branch of the Federal Government (Donihue and Kitchen 229). Each member of the Troika conducts its own calculations based on future economic assumptions and OMB consolidates the inputs into one, official figure for concerned government agencies to use in the preparation of their fiscal budgets.

The forecasts provided by OMB seem to be computed in a rationally relevant way. OMB uses market standards to arrive at a useable figure. According to Pickup, "the Troika uses oil price projections coming from the prices in the futures market for West Texas Intermediate crude oil in the New York Mercantile Exchange. For the 2007 budget, futures prices projected [five] years ahead were used in developing crude oil price projections" (3).

The second step DoD takes in establishing a stable price is in considering the refining costs of a bbl of crude oil. This is an important consideration because the petroleum used by DoD is in the form of refined products such as gasoline, diesel fuel, jet fuel, and diesel fuel marine. The refining costs are not free to DoD and they must be appropriately accounted for in addition to the raw-oil costs. According to Pickup, "This component is estimated using a statistical technique that analyzes the historical data relationship between crude oil prices and refined oil prices" (4). Regression analysis has traditionally been the method used for this calculation, but DoD is considering other statistical techniques to replace tool. For the time period December 2008 to September 2009 (the rest of FY2009) for example, \$21.01 has added to the base price per bbl for refinement costs. Figure 3 provides a complete explanation of costs added to the per bbl price for DoD customers for the remainder of FY2009. However, these prices could change because of DoD's current practice of adjusting stabilized prices as necessary in response to oil's extreme price volatility witnessed in recent times.

Lastly, DoD adds to the base and refinement costs, a surcharge for the overhead costs associated with providing fuel to DoD customers. The surcharge includes costs such as transportation, storage, and administration fees. Figure 4 provides a comprehensive explanation of costs making up the typical surcharge. The surcharge is in place for all activities involved in DoD fuel procurement/distribution to recover actual expenses in handling fuel for DoD customers. This requirement for full-cost recovery is due to the fact that DoD oil purchases are made through the DWCF which will be fully discussed later in this chapter. For the time period December 2008 to September 2009 for example, $13.55 in surcharge was added to the base price per barrel of oil.



	Crude Oil	Refined Product	Product Losses	OSD Cash Adj.	Cost Recovery	Rounding Factors	Transport	SRM	Terminal	Operations
Operations										$2.84
Terminal Operations									$1.53	$1.53
SRM								$3.05	$3.05	$3.05
Transport							$3.01	$3.01	$3.01	$3.01
Rounding Factor						$0.16	$0.16	$0.16	$0.16	$0.16
Cost Recovery					$3.00	$3.00	$3.00	$3.00	$3.00	$3.00
OSD Cash adj				($1.44)	($1.44)	($1.44)	($1.44)	($1.44)	($1.44)	($1.44)
Product Losses			$1.40	$1.40	$1.40	$1.40	$1.40	$1.40	$1.40	$1.40
Refined Mark-Up		$21.01	$21.01	$21.01	$21.01	$21.01	$21.01	$21.01	$21.01	$21.01
WTI Crude	$70.02	$70.02	$70.02	$70.02	$70.02	$70.02	$70.02	$70.02	$70.02	$70.02

Figure 4. Explanation of Costs Added to the Base Price of a Barrel of Oil to Get to Total Price of $104.58. Time Period Covered is December 2008 to September 2009. (From Office of the Secretary of Defense [Comptroller]).

3. Congress Takes Notice

In 2006 Congress officially expressed displeasure with the inaccurate forecasts used by DoD and mandated the Department review/consider alternative methods for forecasting fuel costs. Specifically, Pickup writes that the John Warner National Defense Authorization Act for Fiscal Year 2007:

> . . . requires the Secretary of Defense to submit a report on the fuel rate and cost projection used in the annual DoD budget presentation. The act required that DoD identify alternative approaches, including approaches used by other federal departments and agencies and the feasibility of using private economic forecasting organizations, for selecting fuel rates that would produce more realistic estimates of the amounts required for DoD to accommodate fuel rate fluctuations. DoD is also required to discuss the advantages and disadvantages of each approach and to identify the department's preferred approach among the alternatives and provide a rationale for preferring that approach. Finally, the act further requires that GAO review DoD's report, including the basis for the Secretary's conclusions for the preferred approach. (2)

DoD complied with Congress' mandate and submitted on February 27, 2007, a final report of its analysis on the alternatives to its current forecasting method.

4. The Search for a Method Begins

DoD's search for alternative forecasting methods evaluated forecasting methods practiced by organizations inside and outside of the federal government. Pickup reports that "DoD solicited inquiries from at least [twenty one] federal departments and several independent agencies but did not have information on the exact number" (2). DoD received and used eight responses from the government agencies queried and thirty-eight responses from private forecasters in its comparative analysis.

DoD was especially hopeful to find a federal agency that practiced a more accurate method for forecasting fuel costs. Out of the eight governmental responses, only one organization had a method that warranted further review. Pickup writes, "DoD determined that seven of the eight respondents used DoD's forecast, did not have a forecast method, or did not have a forecasting method that would accommodate the size and complexity of DoD's fuel requirement" (2). Even though the bulk of responses were discouraging, the Department of Energy (DoE) responded with a forecasting method that appeared viable to DoD.

DoE uses the Energy Information Administration (EIA) to provide it with forecast prices for crude oil. According to its own website, the EIA is a statistical unit within the DoE that "provides policy-independent data, forecasts, and analyses to promote sound policy making, efficient markets, and public understanding regarding energy and its interaction with the economy and the environment. By law, EIA's products are developed independently and are not subject to clearance by the Department or other government agencies" (EIA). In initial evaluation, DoD determined that EIA forecast seemed to provide the most accurate prediction of future crude prices and DoD wanted to further assess the EIA method. However, a more thorough evaluation of EIAs methods needed to be conducted before DoD could make a conclusive decision.

5. Analysis Methodology

In its analysis of the alternative forecast methods, DoD conducted four independent scenario-based comparisons to evaluate the various forecasting approaches. The comparisons included forecasting results from DoD's OMB-supplied forecast, DoE's forecast, and a select number of the submissions from the group of thirty-eight private forecasting entities. Pickup points out that:

> According to DoD officials, they were not able to obtain forecasts for each of the 38 private organizations for each scenario DoD evaluated because the historic forecasting data were not always available. Therefore, the number of private organizations compared in each scenario varies. (5)

Forecasted results from the competitors were compared to the actual crude oil prices on a given date. This comparison ultimately determined which forecasting method was the most accurate in achieving a figure near actual crude oil prices.

The four, comparison scenarios conducted compared fuel-price forecasts calculated by the competitors in June 2005 to actual rates for:

- the average price per bbl for the first quarter of FY2006
- the average price per bbl for the third quarter of FY2006
- the average price per bbl for the whole calendar year (CY) 2006
- the average price per bbl for each of the six quarters beginning with the fourth quarter FY2005 and ending with the first quarter FY2007

From the results of these four comparisons, DoD conclusively determined that DoE's EIA forecasting method used in all four scenarios produced figures that were marginally closer, by an average of 1.92 percent to actual crude oil prices than either DoD's or many of the private entities' forecasts. Furthermore, the comparisons also showed that only three of the thirty-eight private entity forecasts outperformed OMB and DoE forecasts in individual comparison scenarios. However, none of the private organizations consistently outperformed either OMB or DoE in all of the scenarios.

By considering its specialized requirements and the results of the comparisons, DoD consequently selected its method to be the best over the DoE and private-firm forecasting alternatives. In her report, Pickup writes:

> DoD concluded that because the results showed only marginal improvement (1.92 percent difference) in using EIA's forecast over OMB's forecast and since no private organization consistently outperformed OMB forecasts in all scenarios, it did not warrant a change from DoD's current methodology. DoD also reported that inaccurate forecasts are pervasive in the current economic conditions based on market volatility. Thus, DoD concluded that changing forecasting sources or methods may not provide more realistic estimates for DoD at this time. (7)

DoD appeared to be content with the status quo and planned to continue using its current method.

6. Flawed Analysis

As mandated by Congress, analysis of alternative forecasting methods was complete and DoD had officially decided to maintain use of its current method. However, GAO reviewed DoD's report of findings and issued the opinion that the DoD analytical methods were flawed. Specifically, Pickup's report to Congress states:

> In assessing DoD's comparative analysis, we found limitations on the scope of the analysis due to the lack of available historical forecast data. Specifically, DoD included [eighteen] months of data or less in each of the comparative scenarios it analyzed and the scenarios did not involve forecasts from the same time period DoD used to set its budget request. (3)

The flaw in conducting the analysis is important because, during the comparative analysis, DoD used forecasts from June 2005 to predict crude oil prices for the various

FY2006 scenarios. However, in real-world forecasting for setting its stabilized fuel price for FY2006, DoD set this price in December 2004, a full six months earlier than the forecasted prices used in the comparative analyses. As stated by Pickup, “When DoD set its fuel rate in December 2004, the forecast it used predicted fuel costs [ten] to [twenty-one] months into the future (December 2004 to October 2005 through September 2006)” (8).

The historical data necessary for conducting a real-world type of comparison was not available because private organizations did not retain their data for record purposes. The lack of historical data used by the other organizations in support of their forecasting methods prevented DoD from conducting a more extensive multiyear comparison of the various methods. DoD even officially acknowledged in its report that had the historical data been available, its use in the analysis would have produced a more ideal comparison. Moreover, one of the economists from DoD who was involved with the comparative analysis agreed that a proper evaluation of a comparison group’s long-term forecasting performance should include several different time periods. The eighteen months worth of data was simply not enough. Could DoD arrive at a sound decision based on flawed results?

In this case, comparisons of the various models would have been more realistic if longer time frames of data would have been available for making forecasts. Forecasts tend to be more accurate when they are made closer to the actual time-frame being estimated. Pickup even reports that the DoD economist that GAO representatives spoke with “agreed that it would have been a more meaningful analysis to use December 2004 forecasts” (8). Therefore, it is fair to surmise that if the forecasts calculated during the analysis used a wider range of data and forecasted over the length of time as DoD traditionally practices in its forecasting, the price variations realized across the various methods would most likely have been greater. So, perhaps, DoD’s forecasting method would provide the best forecast after all.

Another fact to note is that EIA forecasts are only available from the beginning of the month that the forecast was conducted until the end of the following calendar year. This is an important consideration to DoD because of how early its budgeting process begins. In this case, with DoD establishing its stabilized fuel rate for FY2006, EIA would not have been able to provide a forecast for the FY2006 time span because an EIA forecast conducted in December 2004 would have only covered until December 2005.

7. GAO Endorses DoD Decision

After consideration and review of DoD's analysis process, GAO agreed that DoD made the appropriate choice to continue using its own forecasting method for determining the stabilized price for oil. Specifically, Pickup's report states:

> We agree that the results did not provide a compelling reason for DoD to adjust its rate setting approach at this time. Because of DoD's decision to retain its current approach, we reviewed the basis for OMB's forecast to determine if it is based on reasonable assumptions. OMB's forecast is based on the futures market of crude oil. Using futures prices for crude oil seems like a reasonable approach because buyers and sellers are actually making purchases and sales based on their ideas and information about the future price of crude oil. The futures price for crude oil for a particular date would reflect the interaction between buyers and sellers and the best estimate for the price of crude oil at that time. Barring more extensive analysis that might provide additional information to consider in selecting an alternative forecast, we believe that DoD's current method for producing fuel rates is a reasonable approach. (9)

GAO further recommended that DoD consider conducting a similarly styled analysis again in the future after it had accumulated enough of the appropriate historical data that would aid in completing a more accurate comparison of the forecasting methods.

8. Conclusion

Forecasting methods are important to understand because, in this case, forecasting methods practiced by federal entities contribute to budget problems. The inaccurate results realized through forecasting can cause further government inefficiencies by wasting additional time and money in the rush to find funding to make up for the shortfalls caused by inaccurate forecasts. Inaccurate forecasts are just one part of the larger problem that DoD has with fuel costs.

D. BUDGET PROCESS – THE DEFENSE WORKING CAPITAL FUND

1. Overview

This section explains the workings of the DWCF and how volatile fuel prices affect fuel-price forecasts used in budgeting. Additionally, the fact that imprecise forecasts have a negative impact on DWCF and thereby cause additional difficulties in the federal budget system is discussed. Understanding of the DWCF is important because the fund is the mechanism used by DoD to effect payment for the transfer of goods and services, such as fossil fuel products and maintenance work, between the fund's participants. Especially important to understand is the fact that DWCF is a revolving fund. In her handbook, Lisa Potvin describes a revolving fund as:

> A fund in which all income is derived from its operations and is available to finance the fund's continuing operations without a fiscal year limitation. A revolving fund operates on a break-even basis over time; that is, it neither makes a profit nor incurs a loss. Simply stated, a revolving fund activity accepts an order from a customer, finances the costs of operation using its own 'working capital,' then bills the customer who reimburses the fund. (99)

The budgets of the providers and customers utilizing DWCF for transfer of fossil fuel products are especially affected in both a negative and sometimes positive way by unstable fuel prices. This problem is further examined throughout this section.

2. Basic Concept

The DWCF concept has a long history within DoD, but the current version of the fund was implemented in 1996 and divided the fund into four components that serve the Army, Navy, and Air Force, individually, and the DoD as a whole. A fifth component was later added to service the Defense Commissary Agency. Each participating component of the fund is responsible for managing its own cash balance and must continually maintain a positive balance throughout a FY. Specifically, Potvin writes that DWCF "activities are to maintain seven to ten days worth of operating cash and four to six months of capital outlays" (114).

DWCF is unique to the federal government's traditional system for allocating money to government agencies in that the fund is self-sustaining because it generates its own income from operations. Typically, the fund does not receive any direct appropriations in the yearly fiscal budget (except for direct appropriations for mobilization capability) so DWCF is not affected by transitions to and from consecutive FYs. The fund is perpetual from one FY to the next and a continuing budget resolution is not necessary for the fund to continue operating. However, lack of a yearly appropriation does not give fund users free reign to spend as they desire—purchases made through the fund are still accountable to Congress for spending authority and limits. Customers purchasing goods or services from DWCF providers must receive authorization and appropriations from Congress to make those purchases. If any of the fund participants fail to observe regulations, an Antideficiency Act (31 US Code Section 1517(a)) violation could be levied against the offender.

DWCF received its initial funding, called a corpus, through appropriation and transfer of funds from organizations being organized under DWCF when the fund was first established. From that point on, DWCF was designed to be self sustaining. Only rarely, during times of unforeseen or abnormally high expenses outside the control of fund participants, does a Congress appropriate additional fund to DWCF to make up for the shortfall. As stated in Chapter I, during FY2008, Congress appropriated just over an additional $4.2 billion to DWCF because of budgetary shortfalls associated with rising fuel costs.

June Taylor writes, "in the simplest of terms, the DWCF was established to allow the federal government purchase and repair activities to account for costs and revenue as if they were commercial businesses" (28). Later in her article, she continues to state: "[DWCF] was established to provide a funding mechanism for the DoD corporate structures to absorb risk in planning investment programs for maintenance and supply. The intent was to allow DoD organic maintenance and supply activities to make investments in the near term and recoup the costs through future year pricing structure" (28). This means DWCF provides the initial funding to pay the up-front costs for whatever activity the fund participant is providing, for example, fossil-fuel products, and as resources are provided to the end user, those users provide their appropriated funds to reimburse DWCF.

3. Fund Objectives and Benefits

DoD Financial Management Regulations, chapter fifty explains that the DWCF was implemented to accomplish the following objectives:

- Provide a more effective means for controlling the costs of goods and services required to be produced or furnished by government activities and a more effective and flexible means for financing, budgeting, and accounting for the associated costs.
- Create and recognize contractual relationships between DWCF activities and those activities that budget for and order the end products and services.
- Provide managers of DWCF activities the financial authority and flexibility required to procure and use manpower, materials, and other resources effectively.
- Encourage more cross servicing among DoD components and their operating agencies with the aim of obtaining more economical use of facilities.
- Facilitate budgeting and reporting the costs of end products. This will underline the cost consequences of choosing between alternatives. (qtd. in Taylor 28)

DWCF plays an important role in DoD's budget system as it establishes a transfer price that provides full-cost visibility for products and services exchanged between providers and customers. Ray Garrison writes that "the commercial sector of the American economy has long used the management accounting principle of transfer pricing—the price charged when one segment of a company provides goods or services to another segment of the company" (qtd. in Taylor 26). DoD is simply practicing a basic business concept to promote efficiency and full cost recovery between organizations.

Furthermore, utilization of the DWCF perpetuates the concept of Activity-Based Costing (ABC) within DoD. The ABC concept tracks all costs that directly and indirectly contribute to the entire production of a final product or service. This allows for the step-by-step tracking of the value-added activities contributed by various organizations in the production of a good or service. The full cost of the value added by each activity in a production process is useful because the information is used to establish more accurate budgets and aids in making strategic-resource decisions in concerned organizations.

This concept allows for and promotes efficiency in the procurement process because individual customers are able to achieve 100 percent cost visibility in their purchases and manage their budgets for such purchases down to the penny. Furthermore, in having DWCF supplier organizations make bulk purchases of products that will be consumed by end users, savings are realized through economies of scale and individual users of the products/services are not expending time and resources in individual procurements processes.

Lastly, one of the biggest benefits in utilizing DWCF is that the concept aids units in establishing smooth budgets for planned usage by providing budget stability despite unpredictable commodity market price swings. Providers and customers utilizing the fund can establish concrete budgets and remove uncertainty based on stabilized prices established by product/service providers. This topic is discussed in detail in the subsequent subsection.

4. Stabilized Prices

Product and service suppliers who operate under DWCF have an ultimate goal to achieve a net operating result of zero for each FY. This simply means that the entity desires to recover all costs associated with supplying the product or service without generating a profit—basically to just break-even. Therefore, as a means to this end, the supplier establishes a stabilized price for the products/services it will provide to its customers. As discussed in Section C, the stabilized price for a bbl of oil for example, is based on a number of variables that contribute to the total cost to supply that bbl to the end user. The stabilized price usually remains fixed throughout the FY, but recently, due to the volatile price of fuel, suppliers have adjusted their stabilized prices to best reflect actual costs.

The establishment of a stabilized price does not guarantee that a supplier will achieve a zero balance at the end of a FY. The stabilized price may have been established two years in advance of the FY that the price was to become active. As explained in the previous section, this means that the stabilized price most likely differs from the actual cost of providing that good or service. Therefore, the fund will have a realized surplus or deficit on 30 September, the end of the FY. These gains or losses (within reason) are absorbed by the fund each year and then passed on to its customers in the subsequent FY through that year's stabilized price for the concerned service or product. For example, if the fund has a surplus due to operations, customers who purchase the product that caused the surplus in the subsequent years will receive a discounted price.

Federal law requires DWCF suppliers to recover 100 percent of their costs from its customers. Recovery can be accomplished over two years, but no more than 50 percent can be recovered in the second year. As an exception to this rule, Potvin reports that "depots (Navy and Air Force only) do not fall under the annual stabilized tenet of other working capital fund business units. Unbudgeted losses or gains of ten million dollars or more will be recouped or returned in the current fiscal year" (110). Likewise, in recent years, even though oil purchases do not officially fall under this rule as oil is purchased under the Operations and Maintenance (O&M) appropriation, as a testament to the serious budgetary concerns associated with the rising cost of oil, stabilized prices for oil have changed multiple times during a given fiscal. In FY2008, the stabilized price for fuel was changed only twice throughout the year. However, during FY2009, DoD has been more attentive to price changes and had already changed the per barrel price two times by February 2009.

5. Culmination

Entities utilizing DWCF are harmed because of the unpredictable, rising and falling costs of fossil fuels. Rising fuel costs contribute to inaccurate fuel-price forecasts, which contribute to inaccurate budgeting for use of DWCF. Compounding the budgeting problem further, in recent years, fuel suppliers within DoD have had to amend stabilized prices during a given FY to immediately recoup price differences from their customers. This practice is inefficient in that it negates the time, energy and costs dedicated to production of a fiscal budget. Furthermore, organizations are faced with uncertainty because the budgets they had produced prior to a given FY are not accurate so, the organization cannot accurately plan for the future. As a consequence of poor budgeting, DoD and Congressional leadership must move quickly and expend additional time, energy, and resources to provide additional funding for unanticipated fuel costs.

E. INSIGHT INTO OIL PRICE VOLATILITY

1. Overview

According to a report by the Defense Science Board Task Force on DoD Energy Strategy, DoD is the single largest consumer of energy in the United States. Additionally, the report states that, "in 2006, DoD spent $13.6 billion to buy 110 million barrels of petroleum fuel (about 300,000 barrels of oil each day). This represents about 0.8 percent of total U.S. energy consumption and 78 percent of energy consumption by the Federal government" (11). At the national level, the United States currently imports roughly 60 percent of its oil from foreign sources and the percentage is increasing. Consequently, our heavy dependence on foreign sources for petroleum products is problematic to our current and future fuel needs for a number of reasons. Perhaps the most troubling concern is that much of the global petroleum resources reside in countries that are not exactly friendly with the United States; many of which are accused supporters/sympathizers of extremist terrorists groups.

A further cause of concern for oil importing nations is the fact that approximately 94 percent of known global reserves are controlled either directly or indirectly by governments through state-owned companies. Due to national security and economic concerns, oil exporting nations will not reveal specific information regarding their petroleum reserves. As a result, the exact amount of petroleum that remains to be extracted from these countries is imprecisely known and the unknown contributes to price volatility that exists in the global oil markets. Additionally, wide uncertainty exists in estimates of oil reserves that are presently inaccessible because of the lack of costly technology that is required to extract these resources. In other words, the amount of oil remaining to be harvested and our ability to do so are constantly in flux, thus exposing the inherent instability in the petroleum market.

In this section we provide background information on petroleum supply and demand as well as an explanation for some of the reasons behind volatile oil prices.

2. Petroleum Supply and Demand

In the Report of the Defense Science Board Task Force on DoD Energy Strategy conducted in 2008, the following global petroleum statistics are noted, "The world presently consumes about 86 million barrels per day (mbpd). Of this, the United States consumes about 21 mbpd, or, about 24%" (12). DoD remains the largest single consumer of petroleum in the United Sates, however; its requirement is small relative to the entire market. Even with DoD's increasing wartime petroleum consumption, which according to the article "Military Needs Efficient Fuel-Buying Process" is 15 million gallons of fuel per day; overall, DoD's comprehensive demand is only slightly larger than a solitary, major-international airline.

DESC has the expertise to manage and meet the demands of the warfighter by leveraging its robust and intricate global supply network. DESC is successful in meeting its mandate because it has numerous supply points which provide a large variety of fuels to meet the needs of DoD customers. Furthermore, DESC has established relationships and contracts with strategically placed refineries around the world. Especially noteworthy, if required for national security, DoD can legally invoke *eminent domain* over commercial energy contracts. This legal concept allows the United States government to seize private energy contracts and companies provided that reasonable monetary compensation is provided in return, however, this can be accomplished without the owner's consent. Consequently, DoD remains comfortable in its ability to obtain petroleum it needs to perform any mission at any time and any place.

As previously discussed, DESC supports operational forces by purchasing fuel from sources near theater rather than shipping fuel from the United States. Consequently, DoD operations rely heavily upon the commercial, global-petroleum markets for its supplies. There is no question that many of the countries currently exporting oil have less-than-stable relationships with the United States and the relationships with these countries require a higher level of strategic thinking and keen scrutiny in business dealings with them. That being said, DoD demand for fuel continues to grow and DESC strives to find new ways to streamline its petroleum management process, reduce costs, and increase procurement efficiencies while balancing the intricacies of the international, political environment.

3. Causes of Volatile Fuel Prices

Historically, market prices for oil have been very difficult to predict accurately. This instability of market oil prices can be attributed to a variety of factors. From a geo-strategic perspective, many oil exporting countries are far from being democratic, free markets. Many nations face criticism for being corrupt, unstable, and even hostile towards the United States. For these reasons, international tension and political unrest often impact the price of oil. Additionally, over the past several years, tight supplies and a strong global demand from emerging economies such as China and India have influenced the market for oil by putting upward pressure on prices. Currently, world oil prices are near historic highs and the prices witnessed during FY2008 were the highest since the oil crisis of the early 1980s. In FY2005, for the first time in its history, DESC had to adjust its stabilized fuel price mid-year. According to the authors of "More Fight – Less Fuel":

> From 2004 to 2006, DESC fuel sales more than doubled from $5.9 [billion] to $13.6 [billion]., most of the increase being due to the rising prices for petroleum products…DoD operates on a six year Future Year Defense Plan (FYDP) funding horizon. Increases of this magnitude mean that large sums of money must be reprogrammed in order to meet operating costs, wreaking havoc on programs from which the funds are taken. (13)

The rapid increases in fuel costs especially caught the attention of DoD leadership during FY2008 and has reinvigorated cost saving efforts associated with fuel expenditures.

Another issue exerting influence on the market price for oil is the theory of peak oil. Peak oil is the point in time at which approximately half of the extractable oil on the planet has been consumed. At this point, future production of oil is expected to enter a terminal decline. Intuitively, a terminal decline in production signals reduced future supplies and this puts strong, upward pressure on prices. In February 2007, the GAO published a study that addressed peak oil. The report identified twenty-two separate studies on peak oil conducted since 1996 and the general consensus was that peak oil would occur sometime between now and 2040. However, the range of years provided in the GAO's report still leaves great uncertainty. Peak oil predictions are difficult if not impossible to know with any degree of certainty. Nonetheless, even with the uncertainty, the topic by itself coupled with the range of dates that peak oil is expected to occur still cause upward pressure on the per bbl price for oil.

Lastly, a less-obvious contributor to erratic oil prices is the practice of speculation. During 2008 alone, the price of a bbl of oil increased from $69 to $150 in just over three months. On one single trading day, September 22, 2008, the price of oil increased a record $25 in one day. The former director of the Commodity Futures Trading Commission (CFTC), Michael Greenberger, confirmed that there were no supply disruptions during that time that could have justified such an increase. Greenberger states that the crude oil prices were simply driven by hedge funds investors and large trader banks. Moreover, hedge fund manager Michael Masters, in testimony before the U.S. Senate in May 2008, estimated that assets allocated to commodity index trading strategies has gone from $13 billion at the end of 2003 to $260 billion as of March 2008 (qtd. in Hamilton 13). Based on this information it is fair to conclude that a speculative bubble was created not unlike that of the recent housing crisis where 60 percent to 70 percent of oil contracts in futures markets were held by speculative entities, vice, companies that were actual end-users of oil such as home heating oil companies and airlines, for example. To further this point, a *60 Minutes* special titled "Did Speculation Fuel Oil Price Swings?" reports that activity in the futures market had become so great that, "in

2007, 27 barrels of oil were being traded for every one barrel consumed in the United States." This statement highlights the magnitude of the speculative trading that was occurring daily on Wall Street during 2008.

Ultimately, an enormous amount of speculation drove up prices to unprecedented levels until the market adjusted and oil prices stabilized to a level consistent with supply and demand. From July 15, 2008, to the end of November 2008, over $70 billion came out of commodities index funds. During the same time period, gas demand went down 5 percent, yet the price of a bbl of oil dropped $100 or roughly 75 percent ("Did Speculation Fuel Oil Price Swings"). Based on this evidence, it is not unreasonable to assume that speculation caused a huge market swing that was both unpredictable and uncontrolled largely due to a deregulated oil derivates market.

F. CONCLUSION

As highlighted to this point, the inner workings of the commercial fuel market and DoD fuel-procurement procedures are complex and often problematic. In the next chapter we provide an overview of the futures/derivatives market, the theory behind hedging, examples of hedging from the commercial airline industry, and insight into why DoD does not currently participate in the commercial derivatives market.

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III. AN OVERVIEW OF ENERGY HEDGING AND THE FUTURES MARKET

A. OVERVIEW

Recent forecasts for future demand of oil predict rising levels in demand over the foreseeable future. Moreover, prices for fossil-fuel products have been at historically high levels over the past four years and remain largely unpredictable into the future. As highlighted in Chapter II, DoD operations are inherently dependent on oil-based fuels. Although fuel costs represent less than 3 percent of the total DoD budget, they have a significant impact on the department's overall operating costs. Most analysts foresee continued periods of high fuel costs in the future, and with the ever-present possibility of disruptions in the supply of fuel, DoD's overall readiness, force modernization, and ability to fund operations are all at risk. Considering the degree of seriousness that the current situation presents, any potential strategy to help mitigate the risk of rising fuel costs and reduce overpaying for fuel would benefit DoD. One risk-management tool for DoD to consider is to adopt a robust, fuel-hedging strategy by making purchases in the futures market for derivatives. Derivatives allow risk associated with the value of an underlying asset (fuel in our case) to be transferred from one party to another. In this chapter, we provide a clear explanation of the following:

- How the futures/derivatives and options markets work.
- How the energy market is analyzed.
- The theory behind hedging.
- A look into the airline industry's involvement in hedging.
- Guidance for implementing a hedging strategy.
- Why DoD does not currently participate in futures trading.

During the past twenty-five years, significant, sometimes abrupt, changes in supply, demand, and pricing have impacted many of the world's commodity markets, especially those for energy. As experts from the New York Mercantile Exchange (NYMEX), the world's largest physical commodity futures exchange, claim:

> International politics, war, changing economic patterns, and structural changes within the energy industry have created considerable uncertainty as to the future direction of market conditions. Uncertainty, in turn, leads to market volatility and the need for an effective means to hedge the risk of adverse price exposure. (3)

The primary risk-management tools available to large-volume consumers, such as DoD, in the energy markets today are the versatile futures and options contracts found on NYMEX.

The NYMEX is the world's leading, commodity-futures exchange that offers futures and options contracts for light, sweet-crude oil. Crude oil is the world's largest cash commodity in terms of volume and dollars. Nearly 20 percent of the world's entire trade is in oil. NYMEX has a light, sweet-crude contract, which is preferred by refiners due to its low sulfur content. The majority of the world's supply is sour (high-sulfur) crude, but because the sulfur content varies widely, NYMEX contracts based on West Texas Intermediate have emerged as the leader for world oil prices (Kleinman 96).

For a large-scale consumer of oil like DoD, it could be prudent to incorporate price-hedging techniques into its risk-management strategy. This could be accomplished by making some of its purchases in the energy futures market. A price-hedging strategy could potentially insulate DoD from unpredictable and expensive swings in market prices. In fact, commodities markets, such as NYMEX, were originally created to provide a mechanism for producers and consumers to financially protect themselves through implementation of various hedging strategies. With an adequate hedging strategy, could DoD effectively stabilize its fuel costs? Spinetta seems to believe so and writes the following in "Fuel Hedging: Lessons from the Airlines:"

> Developing a risk management strategy would allow DoD to hedge against unwanted budget risks. Hedging eliminates, or at least reduces, oil price volatility, smoothes the budget, and improves cash management. Hedging also reduces price distortion that results from charging internal customers a stabilized price that does not reflect market prices and thus, does not reflect the actual cost of government purchased energy commodities. (Spinetta 30)

B. FUTURES/DERIVATIVES AND OPTIONS MARKET

Derivatives are financial contracts that derive their values from an underlying asset such as fuel. The basic building blocks for all derivative contracts are futures. Futures markets are markets in which commodities to be delivered or purchased at some time in the future are bought and sold. The futures contract is the basic unit of exchange in the futures markets. The buyer is known as the "long" and agrees to take delivery of the underlying commodity. The seller is known as the "short" and agrees to make delivery. Very few contracts traded each year actually result in the physical delivery of the underlying commodity; less than 1 percent in the case of energy. Instead, traders often offset (a buyer will liquidate by selling the contract, the seller will liquidate by buying back the contract) their futures positions prior to the contract reaching maturity. The difference between the initial purchase or sale price and the price of the offsetting transaction represents any profit or loss.

Futures contracts traded on NYMEX are regulated and settled daily based on their current-market values. The key players in the futures market are hedgers, speculators, and brokers. Hedgers use futures to mitigate the risk of price changes by shifting the risk onto other market participants such as speculators. Speculators may assume the price risk that hedgers attempt to avoid in the hope of making a profit. Although speculators typically have no commercial interest in the commodities they trade, their desire to make a profit motivates them to collect market information regarding the supply and demand of commodities to anticipate the potential impact of this information on prices. Lastly, there are brokers, who actually make the trades. For NYMEX to be an efficient and effective risk management instrument, its futures market maintains a fair balance of both private speculators and commercial hedgers (Kleinman 3).

Futures contracts trade in standardized units in an extremely competitive and highly visible, continuous-open auction. The futures market is available for widely diverse participation, and efficient price discovery reflects an accurate picture of the market. Every contract on NYMEX for a specific commodity is identical with the exception of price. Each commodity has different specifications, but the contract is the same. The size of the contract determines its value, and to calculate savings or profit as a result of any price movement, you need to know the following information: contract size, how the price is quoted, minimum price fluctuation, and the value of the minimum price fluctuation (Kleinman 3).

The following is an example from James Williams' "Crude Oil Futures Prices" of the contract specifications for crude oil traded on the NYMEX:

> **Trading unit:** Crude Oil Futures trade in units of 1,000 U.S. bbls (42,000 gallons).
>
> **Trading Months:** Crude Oil Futures trade 30 consecutive months plus long-dated futures initially listed 36, 48, 60, 72, and 84 months prior to delivery. Additionally, trading can be executed at an average differential to the previous day's settlement prices for periods of 2 to 30 consecutive months in a single transaction. These calendar strips are executed during open outcry trading hours.
>
> **Price Quotation:** Crude Oil Futures are quoted in dollars and cents per bbl.
>
> **Minimum Price Fluctuation:** $0.01 (1¢) per bbl ($10 per contract).
>
> **Maximum Daily Price Fluctuation:** Futures: Initial limits of $3.00 per bbl are in place in all but the first two months and rise to $6.00 per bbl if the previous day's settlement price in any back month is at the $3.00 limit. In the event of a $7.50 per bbl move in either of the first two contract months, limits on all months become $7.50 per bbl from the limit in place in the direction of the move following a one-hour trading halt. (Williams)

The process of physically executing a transaction on the trading floor is fairly simple. The method of trade is referred to as the "open outcry auction" process. The NYMEX brokers explain the fundamentals of a trade in "A Guide to Energy Hedging":

> The process starts when a customer calls a licensed commodities broker with an order to buy or sell futures or options contracts. The broker sends the order to his firm's representative on the trading floor via telephone or computer link. An order slip is immediately prepared, time stamped, and given to a floor broker who is an exchange member standing in the appropriate trading ring.

> All buy and sell transactions are executed by open outcry between floor brokers in the same trading ring. Buyers compete with each other by bidding prices up. Sellers compete with each other by offering prices down. The difference between the two is known as the bid-ask spread. The trade is executed when the highest bid and lowest offer meet. When this trade is executed, each broker must record each transaction on a card about the size of an index card which shows the commodity, quantity, delivery month, price, broker's badge name, and that of the buyer. The seller must toss the card into the center of the trading ring within one minute of the completion of the transaction. If the last line on the card is a "buy," the buyer also submits the card to the center of the ring; the card is retained by the Exchange as part of the audit trail process. The cards are time-stamped and rushed to the data entry room where operators key the data into the Exchange central computer. Meanwhile, ring reporters listen to the brokers for changes in prices and enter the changes via hand-held computers, immediately disseminating prices to the commercial price reporting services as they simultaneously appear on the trading floor wallboards. (5)

The relationship between the futures pricing and the cash market is fundamental, the cash price (spot price) is what the commodity could be purchased for in the market place today, and the futures price represents the current-market opinion of what the commodity could be purchased for at some time in the future. In a stable environment of adequate supply and demand, the future-delivery price will be approximately equal to the present-cash value plus the associated costs to carry or store the commodity (carrying costs) from present to the future-delivery month. Under normal market conditions, the price of a commodity for future delivery should be equal to the spot price plus carrying charges.

It is very common to see an upward trend to the prices of distant contract months, and the dynamic is explained by the brokers at NYMEX:

> Such a market condition is known as 'contango' and is typical of many futures markets. In most physical markets, the crucial determinant of the price differential between two contract months is the cost of storing the commodity over that particular length of time. As a result, markets which compensate an individual fully for carry charges—interest rates, insurance, and storage–are known as full contango markets, or full carrying charge markets. (7)

When there is a lack of supply, the reverse market condition appears resulting in a scenario where the nearby month trades at a higher price relative to future months. This situation is referred to as *backwardation* and can often be a result of seasonal influences. As a futures contract approaches its maturity or delivery date, little price difference is seen when compared to that of the spot price. The futures and cash prices move toward converging as the premiums typically associated with futures dissolve over time.

Additional flexibility in managing risk is provided by the "options" feature associated with futures contracts. NYMEX economists explain how options work:

> There are two types of options: calls and puts. A call gives the holder, or buyer, of the option the right, but not the obligation to buy the underlying futures contract at a specific price up to a certain time. A put gives the holder the right, but not the obligation to sell the underlying futures contract at a specific price up to a certain time. A call is purchased when the expectation is for rising prices; a put is bought when the expectation is for neutral or falling prices.
>
> The target price at which a buyer or seller purchases the right to buy or sell the options contract is the exercise price or strike price. The buyer pays a premium, or the price of the option, to the seller for the right to hold the option at that strike.
>
> An options seller, or writer, incurs an obligation to perform should the option be exercised by the purchaser. The writer of a call incurs an obligation to sell a futures contract and the writer of a put has an obligation to buy a futures contract. (50)

Buying options is very similar to buying insurance; the only cost is the premium. Options provide hedgers with the ability to protect themselves in the event of adverse price shifts while participating in favorable price moves. The option premium declines over time and when it expires become worthless. NYMEX endorses the value of options: "By using options alone, or in combination with futures contracts, strategies can be devised to cover virtually any risk profile, time horizon, or cost consideration" (51).

Option sellers receive a premium from buyers that is based on four factors: futures price relative to options strike price, time remaining before options expire, volatility of underlying futures price, and interest rates. Options trading occurs in an open outcry market, similar to futures trading. However, while futures values reflect the overall worth of the commodity plus the carrying costs, options values are linked to the futures contract by the ability to exercise that option.

C. ANALYZING THE ENERGY MARKET

Technicians use a process called "charting" to define price levels at which commodities should be bought or sold. Charting and trend lines are defined by the NYMEX brokers:

> Charting is the practice of recording, in graph format, the market price movements of a particular commodity over time…Daily price movements are plotted as high, low, and closing prices help the trader determine trends, resistance points at which prices should not be easily exceeded, and support points below which prices should not easily fall. These technical signals are used by traders to indicate when to buy or sell.
>
> Technical traders always trade with the trend, never against it. While there will always be moderate rallies and downtrends and moderate reactions and uptrends, countertrend movement is seldom sustained. (47)

The following additional techniques are also used by the experts at NYMEX for analyzing market trends:

> **Historical Volatility:** Analysis of a commodity's past price variability based on time from and price interval.
>
> **Moving Average:** Moving average (open, high, low, close, midpoint, average) to follow the trend signal data fluctuations, and signal long and short positions.
>
> **Ratio:** Despite large fluctuations in price, many commodities have price relationships. By calculating and analyzing the ratio, overvalued and undervalued markets can be found.
>
> **Rate of Change:** Monitors and calculates the market's rate of change relative to previous trend intervals, as specified in the value input.
>
> **Relative Strength Index (RSI):** Study to measure the market's strength and weakness. A high RSI (>70) indicates an overbought or weakening market, and a low RSI (<30) an oversold, bear market.

Stochastic Oscillator: A computer-generated overbought/oversold indicator whose traditional interpretation is similar to that of the RSI. A high stochastic reading (>80) indicates an overbought, or weakening, market and a low reading (<20) indicates an over-sold market.

Support/Resistance/Reversal: Levels determined through technical analysis that indicate trading support, resistance, or the reversal (inverse) of a market price in a specific time frame. (48)

Figures for volume and open interest are also important and used on a regular basis as a technical trading tool. Volume reflects the total number of trades of a given commodity future on any given day. An increase in volume usually is an indicator that the current price trend is accurate and will likely continue. Changes in average volume figures often indicate when the market is approaching a major high or low. Open-interest markets are outlined by the NYMEX professionals:

> Open interest refers to the number of long and short positions in a specific contract which have not been liquidated or offset by an opposing purchase or sale by the same participant. Increasing open-interest figures are considered supportive of the underlying price trend. That is, they may indicate market strength during periods of rising prices or the support of a downward trend during periods of market weakness. Similarly, decreasing open-interest figures during price trends are seen to indicate a technical weakness in the market—a possible dip or reversal based upon the liquidation of open interest. In addition, open interest can also indicate that there is commercial use of a futures contract. (48)

Both volume and open-interest figures can be combined with any major technical analysis system to provide useful, time-sensitive information to aide in the decision-making process for the trader. Correlation between open interest and volume can also be analyzed to reveal a degree of support which may exist for a certain price trend.

D. THE THEORY BEHIND HEDGING

Futures contracts have been used in the United States for more than a century as a reliable way to manage cash-market-price risk. If DoD were to use a hedging strategy, it would be able to lock in fuel prices in advance and thus, reduce the potential for unanticipated loses. NYMEX brokers outline their position on hedging:

> Hedging reduces exposure to price risk by shifting that risk to those with opposite risk profiles or to investors who are willing to accept the risk in exchange for profit opportunity. Hedging with futures eliminates the risk of fluctuating prices, but also means limiting the opportunity for future profits should prices move favorably.
>
> A hedge involves establishing a position in the futures or options market that is equal and opposite of a position at risk in the physical market. For instance, a crude oil producer who holds (is "long") 1,000 bbls of crude can hedge by selling (going "short") one crude oil futures contract. The principle behind establishing equal and opposite positions in the cash and futures or options markets is that a loss in one market should be offset by a gain in the other market. (44)

Hedges work because cash prices and futures prices typically move together, converging as each delivery month contract approaches expiration or maturity. The purpose of a hedge is to avoid the risk of adverse moves in the market that would result in heavy losses. The cash and futures markets do not have a perfect relationship; therefore, a perfect hedge is nearly impossible. However, an imperfect hedge is often a much better alternative than no hedge at all in a potentially volatile energy market.

There are two basic types of hedges: a short hedge and a long hedge. The short hedge is known as a "seller's hedge" and is commonly used to protect inventory value. DoD would be more likely to take advantage of a long hedge. A long hedge is the purchase of a futures contract by someone who would typically buy in the cash market. It is used to protect against price increases in the future. For example, the use of a long hedge would allow DoD to establish a fixed cost for that commodity. The expert brokers at NYMEX account for why sellers agree to fixed-price contracts: "A fuel marketer may offer customers fixed-price contracts for a number of reasons: to avoid the loss of market share to other marketers or alternative fuels, to expand market share; or to bid on municipal contracts requiring a fixed price" (45).

The term "blind hedge" is used to describe a technique where a hedging strategy is established and there is no deviation from the planned execution of the hedge (i.e., adjusting volume, contracts, and/or entry and exit points). The opposite of a blind hedge is referred to as a "selective hedge." NYMEX officials comment on the use of a selective hedge:

> In a selective hedge, the execution of the overall strategy can be fine-tuned to better reflect ongoing cash market conditions. Thus, if a third case of continuously increasing postings were assumed, it is unlikely that the producer would blindly stick to his losing short hedges, rather than liquidate early to contain his future losses. A selective hedge, for example, might link the volume to be hedged to an ongoing assessment of the cash-futures basis relationship and the perceived likelihood of a reduction in posted prices. (46)

An effective corporate hedging strategy is typically developed by a team of economists who can ensure the use of appropriate techniques as well as provide proper oversight. Finding an optimal mix for percent of yearly fuel purchases to hedge would depend on current market conditions, anticipated demand, and expected fuel price fluctuations.

E. THE AIRLINE INDUSTRY'S INVOLVEMENT IN HEDGING

Much like DoD, the airline industry is exposed to risks associated with oil price volatility. Spinetta notes the following: "For every $1.00 increase in fuel, the airlines collectively pay $425 million in additional operating costs. Consequently, most major airlines have developed a risk-management strategy and hedge some portion of their jet fuel needs" (32). For the airlines that do hedge, they do so by participating in the commercial-derivates markets. Further, industry analysts have discovered a direct correlation between airline profitability and percent of fuel usage hedged; namely, the more the airline hedged fuel purchases, the more profitable they were. Obviously, DoD is not concerned with being profitable; however, they are concerned with reducing shocks to its budget as a result of large increases in fuel costs.

Fuel-price, risk-management techniques were first adopted by the airline industry in 1989. To hedge their fuel-cost risks, airlines use derivative instruments based on jet fuel, crude oil, or heating oil. As fuel prices have continued to rise in recent years, airline executives have discovered that it is nearly impossible to pass higher jet fuel prices on to passengers by raising ticket prices (due to the highly competitive nature of the industry). As a result, airlines practicing an effective hedging strategy have been hurt the least by rising fuel costs. The key to a successful strategy is in finding an optimal mix that balances risk with the amount of protection appropriate for the company.

An MSNBC article titled "Airlines Hedge Against Soaring Fuel Costs" reports there are many approaches that the airlines take to hedging and most use a combination of strategies to reduce risk:

> They can buy a "call option" that gives them the right to buy fuel at a certain price.
>
> They can also use "collar hedges," a combination of rights to buy and sell at set prices ("call" and "put" options). Collars provide protection from a decline in prices but less upside if prices rise.
>
> Airlines also use swaps, contracts that require them to buy oil or fuel on a certain date at a set price. These are risky – one party in a swap wins, the other loses. (2)

Southwest Airlines has emerged as the industry leader by aggressively pursuing methods of acquisition for jet fuel at the lowest possible price. Southwest began engaging in fuel hedging in 1999, when oil was just $11 per bbl, and since then, the carrier has hedged between 70 and 80 percent of its fuel consumption each year. Peter Pae writes in "Southwest Airlines Reaps Benefits of Fuel Hedging Strategy" that in 2007 alone, "the airline claimed to have saved over $727 million by locking in lower fuel prices in prior years. So far, the carrier hasn't had a year when it lost money on fuel hedges" (3). As a result of the fuel cost savings realized by Southwest, they have been able to avoid charging additional fees to make up for rising fuel costs and have also continued to expand operations. Southwest's 2007 Annual Report details that the Company had a mixture of futures contracts in place and ultimately hedged over 70 percent of its 2008 fuel requirements at an average crude oil equivalent price of $51 per bbl. Moreover, they plan to continue this posture into the future:

> Based on current growth plans, the Company also has fuel derivative contracts in place for over 55 percent of its expected fuel consumption for

> 2009 at approximately $51 per bbl, nearly 30 percent for 2010 at approximately $63 per bbl, over 15 percent for 2011 at $64 per bbl, and over 15 percent in 2012 at $63 per bbl. (B-50)

Since 1999, hedging has saved Southwest $3.5 billion. Often, the company's hedging strategy alone, has determined whether it realized a profit or a loss.

Transactions associated with hedging strategies all carry a price tag. Southwest spent $52 million on hedging premiums in 2007. Hedging premiums rise and fall with the price of oil and new trades are extremely expensive. Furthermore, hedging is inherently risky and airlines can lose money if oil prices decline and their options have expired. For example, Continental Airlines reported a loss of $18 million in the first quarter of 2007 as a result of an ineffective hedging strategy.

Many lessons can be taken from the fuel-price-protection strategy that Southwest employs. For DoD, protection from volatile fuel prices would allow for increased stability in its overall cost structure. A powerful hedging strategy would effectively serve as insurance against unforeseen fuel costs. Fuel-cost savings realized could, in turn, be used to further fund existing programs and operations. Additionally, stable fuel costs would provide a more accurate budget and assist DoD in planning for the future needs and demands of its force.

F. GUIDANCE FOR IMPLEMENTING A HEDGING STRATEGY

The ultimate goal of an effective hedging strategy is to stabilize energy costs. The economists who wrote "Hedging Your Energy Cost Bets" provide the following example to illustrate how a very basic futures contract could be used to protect against adverse fuel prices:

> On July 23, you project your winter natural gas consumption volume requirements for January to be 10,000 [Million British Thermal Units] MMBTU and purchase a January futures contract giving you the right to purchase that amount of gas at $3.00. Your motivation is to protect against an increase in prices, and you are willing to take the chance that the price might be below that option price in January. The current gas price for immediate delivery may be lower or higher than $3.00 at the time

> you buy the futures contract. That is immaterial because you aren't buying the gas then. At that time you are only contracting to buy the gas for delivery in January.
>
> On December 27 (the last day of trading before the option expires), you sell out the futures position and simultaneously purchase the needed gas in the physical market. Two possible scenarios could be: a settlement at a January price of $6.00, or a settlement at a January price of $2.00. Note that after all is said and done, you've paid $3.00 for the gas independent of the market price. (11)

In both scenarios, the stabilizing effect of a hedging strategy is noted. When you sell for $6.00, you have saved a net of $3.00. Conversely, when you sell the future for $2.00, you have only lost $1.00. Each scenario provides a certain degree of protection against large market swings. The added benefit is in the cost savings recognized when the market moves in the direction that you have predicted (up, normally).

There are many different approaches to hedging and each is a several-step process. Whichever strategy is agreed upon, it is paramount that the hedging organization establishes certain business rules (policies and procedures) to govern its hedging activities. Ideally, a risk-management committee would oversee the hedging activities. Adequate training and education as well as expert consultation are all cornerstones to any successful hedging strategy. Expert advice should include various computer models which can be used to predict daily, two-week trends, and long-term prices based on information that is publicly available. In "Hedging Your Energy Cost Bets," Dean Smith, Manager of Business Energy Solutions at DTE Energy in Detroit, Michigan lists three important elements to work into a risk management strategy:

- Know your company's fuel requirements and price risk tolerance before you negotiate fuel supply contracts.
- Work with your purchasing and financial personnel to evaluate the costs and benefits of potential risk-management strategies.
- When developing energy budgets, consider using NYMEX futures prices and other forward-looking information available through the U.S. Energy Information Administration. (13)

G. WHY DOD DOES NOT PARTICIPATE IN THE FUTURES MARKET

In 2004, at the direction of the Under Secretary of Defense (Comptroller), the Defense Business Board was tasked with investigating the feasibility of DoD hedging against volatile fuel costs by participating in the commercial futures market for derivatives. An initial concern was expressed by the board that any government participation in the free markets would either directly or indirectly influence the market. Due to the large volume of fuel that the government purchases each year, if it began trading in the futures market, the percentage of the entire market that would be controlled by DoD could be cause for concern to investors. Many believed that DoD investment in derivatives trading would disrupt and overwhelm the market; however, the Defense Business Board concluded that DoD could devise a hedging strategy that did not disrupt commercial markets. The data showed that while DoD was indeed a large consumer of fuel, its fuel consumption did not exceed that of a major airline by a significant amount. In essence, DoD would play the same role as an efficient business hedging its fuel costs by using derivatives instruments. This could potentially add liquidity and hence efficiency to the market. Still, the Defense Business Board ultimately recommended that DoD refrain from participating in the commercial derivates market. The Board stated that the political and legislative effort required to devise such a program would not be justified by the potential benefits. The Defense Business Board claimed that DoD could cope with unanticipated fuel price increases and cited the following reasons against a future DoD fuel hedging program:

> As a whole, DoD is not highly exposed to fuel price volatility. Although DoD spent close to $4 billion on fuel in FY2003, fuel costs represents about 1 percent of the total DoD budget compared to 10 percent of the operating expenses of a typical major airline.
>
> The largest unanticipated growth in fuel prices during the past ten years cost DoD $1.7 billion. This is likely an extreme case, but still represents only about 0.5 percent of the DoD budget.
>
> In response to fuel price increases, Congress always either has authorized supplemental funds or has funded the Working Capital Funds to cover price increases.

Price-hedging does not protect against the negative impact demand volatility has on DoD's budget.

The DoD Comptroller told the Board's Task Group that, while unanticipated price increases are bothersome, from his standpoint DoD has been able to cope with them without major program disruptions. (6)

• There is a dollar cost to hedging:

Administrative costs to manage a hedging program might amount to a few million dollars per year.

Transaction costs (that is, fees for hedging in commercial markets) could be in the tens of millions per year depending on the type of hedges in place and the level of risk mitigation.

During periods of rising fuel prices, a hedging program would save DoD money. Likewise, a hedging program would cost DoD money in a declining market. Over time, the total cost of a hedging program would be roughly equivalent to that of an unhedged purchase program plus the administrative and transaction costs. (6)

• There is a potential political cost to hedging:

Laws must be changed to give DoD authority to engage in price-hedging through the use of non-physical futures and other financial instruments sold in commercial markets. Substantial political capital may be required to persuade Congress to authorize fuel hedging.

There is a risk of public criticism of DoD's use of hedging/derivative instruments. Comparisons to corporate misdeeds, unfair though they may be, are possible. (7)

However, the Board did recognize the gravity of the issue DoD faced in regard to protection against volatile fuel prices. Ultimately, they recommended a low-risk, non-market hedging pilot program. In this program, DoD and the Department of Interior's Minerals Management Service (MMS) would engage in an "intergovernmental hedging" arrangement. The Board outlines how the relationship would work:

MMS generates approximately $4 billion per year in revenue through leasing both off-shore and on-shore energy resources. Pricing for those

> resources fluctuate in direct proportion to indexed fuel prices. When fuel prices go up unexpectedly, MMS "makes" money and DoD "loses" money and vice versa. OMB could manage the hedge during budget execution by transferring funds between Interior and Defense during budget execution depending on which Department benefits from unanticipated price increases. This shift could at least partially offset the effects of unanticipated fuel price changes on both parties. (9)

Under this pilot program, hedging fees and transaction costs would not be a concern. Additionally, this option would be less transparent than a hedging program in the futures market and provided that the program failed, the results would not be scrutinized publicly and political embarrassment could be avoided.

Currently, there are various legal hurdles preventing DoD participation in the futures market. The Defense Business Board found three main legislative challenges preventing the implementation of a commercial hedging program. First, DoD has no specific authority to engage in transactions involving derivative instruments. Second, DoD lacks authority to derive cash benefit from liquidated positions in financial markets. Cash from liquidated hedging positions should ideally go into DWCF; however, it currently goes directly back to the Treasury. Lastly, the GAO has not ruled on whether hedging programs aimed at reducing budget risk is an authorized expense for any federal agency (39). Conversely, it is our belief that a strong argument, backed by empirical evidence outlining the benefits of a hedging program, could be the catalyst needed to elicit a change in government policy and ideology.

There is no argument that an effective hedging plan could reduce uncertainty and risk associated with fuel prices for DoD. Furthermore, the need for supplemental funding to make up for unanticipated fuel costs could be eliminated. However, because of a legacy ideology on the benefits of participation in the derivatives market, government investment in such markets is viewed as too risky of an endeavor.

H. CONCLUSION

In considering the broad manner that this chapter outlined the principles of energy hedging, the potential usefulness of such a strategy is clear. Every corporation or business has different requirements and varying propensities towards risk and the futures and options market is available for all levels of participation depending on need. Spinetta elaborates on the impact that a fuel hedging program could have should DoD adopt this course of action:

> In contrast to the current approach, hedging would provide a stable budget. Policymakers would know the true cost of their budget decisions because of stabilized prices would match actual cost. Most importantly, hedging improves cash-flow management to ensure that the necessary funds are available to meet broader corporate objectives. Hedging eliminates the need to seek supplemental funding due to price fluctuation, eliminates disruptions to nonfuel programs caused by unanticipated requirements to pay higher-than-expected fuel bills, and eliminates fuel prices as a concern for DWCF management. (30)

Last year (2008), fuel prices were exceptionally volatile. During the summer months alone, prices rose from roughly $55 per bbl to nearly $150 per bbl. Obviously 2008 would have been an ideal year to have had a large portion of DoD's fuel usage hedged. In the following chapter, we provide a quantitative analysis of the effect that DoD participation in the derivatives futures market would have on the price of a bbl of oil as well as a look into potential cost savings or losses that could have been realized in regards to DoD's budget.

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IV. QUANTITATIVE ANALYSIS

A. CHAPTER OVERVIEW

This chapter provides an explanation for and reports the results of the quantitative analysis conducted in support of our project. The empirical approach undertaken was to determine whether DoD participation in the commercial futures market for derivatives would have a discernable impact on the market price for oil and how much money DoD could potentially save/lose as a participant. This chapter is structured to first provide technical information and background on mathematical theory necessary to understand our approach and calculations. We then justify why our chosen mathematical operations apply to our problem and further emphasize why our results are reasonable and acceptable. Lastly, we provide tables that report our results followed by a general discussion on our findings.

B. PRICE ELASTICITY

1. Overview

To test whether government participation as a buyer in the futures market would have a drastic effect on the per bbl price for oil, we calculated the expected price difference had DoD made purchases on the futures market over a finite period of time. In performance of our calculations, we made use of the concepts behind the short-term *Price Elasticity of Demand* (PED) for crude oil. This method was chosen because of the perceived reasonableness the calculation results would produce and for the simplicity in understanding the associated concepts.

This section explains PED and presents our calculations based upon data from 2006, 2007, and 2008. The figures used in the computations account for DoD fuel usage in barrels (bbls), bbls of oil traded on the futures market, and the price paid in American dollars for a bbl of oil on NYMEX. All futures data was collected from the Web site, EconStats.com, which compiles data directly from NYMEX. All DoD fuel price/usage figures were provided by DESC. In the interest of brevity, most computational detail is suppressed. As an example to the process, we show the calculative procedure for the first of each type of computation and merely report the results in every other instance.

2. Explanation of Price Elasticity of Demand

PED is a useful instrument from the science of economics, which focuses on the change of a price in relation to a change in quantity demanded. The tool aids in predicting demand or price behavior when there is a change in either one of these variables. PED aids in answering such questions as what would happen to total revenue generated from the sale of a specific good if the price for that good were to be increased. Intuitively, one would think that an increase in the price would generate more revenue. However, in accordance with the laws of supply and demand, when a price increases, demand for that item tends to decreases as a consequence. Therefore, revenue would be expected to decrease. So, what exactly could be expected to happen? Would a seller generate additional or lose more revenue by increasing the sales price? PED answers such questions in providing a way to determine which possible outcome would have the most likely effect on overall revenue. Ultimately, the answer to these questions depends on how elastic or inelastic the PED for the product actually is.

Plainly stated, inelastic means that demand does not change very much in relation to a change in price and elastic means the opposite—quantity demanded does change more in relation to price. To explain further, PED has five variants of measurement:

- Perfectly Inelastic Demand—where elasticity is equal to zero. No change in demand is expected regardless of price.
- Inelastic Demand—where elasticity is less than the value of one or where the quantity demanded changes by a smaller percentage than that of price. A price increase will increase revenue while a price decrease will decrease revenue.
- Elastic Demand—where elasticity is greater than the value of one or where the quantity demanded changes by a larger percentage than that of price. A price increase will decrease revenue while a price decrease will increase revenue.

- Perfectly Elastic Demand—where any change in price will cause the quantity demanded to fall to zero. Therefore, revenue will fall to zero.
- Unit Elastic—where elasticity of demand is exactly equal to one. This means that demand is neither elastic nor inelastic. Any type of price change will not produce a change in revenue.

Additionally, two types of calculations, the *short-term* and *long-term* values for PED can be calculated. Short term is generally accepted in the science of economics to be of duration less than one year while long term is one year or greater. The only difference between the two calculations is the passage of time. Many factors can have an effect on PED, but time is one factor that has the greatest influence because as more time passes, consumers have more of an opportunity to make a change in or find a substitute for a product that experienced an increased change in price. Consequently, long-term PED tends to always be more elastic than in the short run because people are expected to demand less of a product over the passage of time if the price were to have increased for the concerned item.

For this project we use an algebraic manipulation of the PED equation to predict the expected, percent change in the short-term price for a bbl of oil if DoD were to participate in the futures markets located within the United States. The short-term calculation was chosen because short-term issues have the biggest effect on DoD's budget. Anthony Andrews writes that in 2007, 1.9 percent of DoD's entire budget authority was for fuel expenses (1). When spending on a particular good takes up a large portion of a budget as in DoD's case, demand for that good over the long-term tends to be more elastic for reasons as explained above. Thus, DoD has the opportunity to balance fuel expenses in response to a price change in the long-term. However, because of the nature of its operations, DoD must accept the consequence of higher fuel expenses in the short-term because of the nature of current DoD fuel procurement methods. Moreover, there are essentially no acceptable substitutes for the crude oil products that DoD must have. Therefore, the short-term PED is an appropriate analysis tool for this project because the short-term time frame would most quickly feel the effects of DoD participation in the futures market.

3. Mathematical Foundation for PED

To reiterate, PED is a measure of how sensitive quantity demanded is to a change in price. More precisely stated the calculation measures the percentage change in quantity demanded caused by a one percent change in price. The calculation is accomplished by simply taking the percentage change in quantity and dividing by the percentage change in price. Since the percent change in quantity (numerator) or the percent change in price (denominator) could be a positive or negative number, the result of such calculation yields a positive or negative number sans a unit of measure. As expected, the larger the absolute value of the numerical result from the PED calculation, the more sensitive demand is to a one percent change in price. A negative value simply indicates a decrease in demand while a positive value denotes an increase. Mathematically stated, PED, represented as (E_D) is given below:

$$E_D = \frac{\text{\% Change in Quantity Demanded}}{\text{\% Change in Price}}$$

Throughout the rest of this project, the above equation is represented by an abbreviated version of the equation stated as:

$$E_D = \frac{\% \Delta D}{\% \Delta P}$$

To find the percent change in demand or price, we use the traditional method for calculating a percent change by dividing the numerical amount of change by its starting value. A visual representation of the formula is as follows:

$$\text{\% Change in Price (P)} = \frac{(P_1 - P_0)}{P_0}$$

The mathematical equation for the percent change in price was chosen to provide an example. As stated above, percent change in quantity is calculated the same way. To do so, one must only change the variables in the equations from “P” to “Q.”

The result of the PED calculation represents only the effect a price change would have on quantity demanded if all other influences on demand remain unchanged. Understanding this is especially important in relation to petroleum markets because of the various causes for price volatility as explained in Chapter II, Section E. Moreover, the supply and demand for a commodity such as oil is sensitive to a number of factors besides the current market price. For example, one factor, income, or in DoD's case, an appropriated budget, dictates the amount of fuel DoD will be able to purchase. Therefore, such effect can have influence on PED. Any number of changes in the world could affect market supply and demand behavior in reality. For purposes of this project, we assume all other influences remain constant and only DoD purchases of crude oil on the futures market had any kind of supply/demand effect on the change in price. Our computed figures for PED isolates the price elasticity to the market of our primary interest and helps to negate additional factors occurring outside the United States that could have an effect on elasticity as described.

Lastly, elasticity calculations are based on past data. This means that anything else could happen because of the other influences on the price of oil as described above. Use of PED for determining what would happen in another variable if one were to change is extrapolation. Small price changes are thought to be accurate, but large changes could potentially cause elasticity to change as a result. It is very difficult to calculate PED accurately because it is impossible to fully isolate every influence outside the market. However, PED is a good and acceptable estimator for the purposes of this study.

C. APPLICATION

1. Overview and Explanation

PED for oil is an important calculation to governments and economist alike for one important reason—oil can have vast impact in shaping economies. John Cooper writes that oil is the primary source of energy that supplies 40.6 percent of world energy demand (3). Since this source of energy is so important to so many economies and budgets, the relationship between supply, demand and oil prices are important for one to understand. Consequently, a number of organizations and governments have calculated short-term PED for oil. In conducting the literature review for this project, we uncovered a wide range of PED calculations that can be considered to be relatively close in value.

However, from a statistical point of view, there is not much precision in the values. The following table, Table 1, details five different values we uncovered:

Source	Short-Term Value
Adelman (190)	.1
Brown and Phillips (5)	.56
Cooper (4)	.06
Hall and Lieberman (103)	.15
Kalymon (348)	.5

Table 1. Short-Term Price Elasticity of Demand for Crude Oil.

We feel the values of these above listed PEDs to be reasonable based upon James Hamilton's research which reports that short-term PED for oil is expected to be below the value .10. Specifically, he writes:

> Figure [5] illustrates why it has to be a small number. The horizontal axis measures the cumulative logarithmic change in real GDP at a given date relative to where it was in 1949, so that two years separated by a distance of 0.1 on the horizontal axis correspond to a growth of real GDP of about 10% between those two years. The vertical axis measures the cumulative logarithmic change in U.S. oil consumption. Despite the 5-fold fluctuations in oil prices over this half century, it is rare to see much disturbance to the long-run trend of increasing oil use over time. The biggest exception occurs between 1978 and 1981, when U.S. oil consumption fell 16.0% while U.S. real GDP increased by 5.4%. This is one episode where one might clearly attribute this to the demand response to a shift in the supply curve brought about by exogenous geopolitical events, namely, a loss of Iranian production of 5.4 million barrels per day in the immediate aftermath of the 1978 revolution, and an additional 3.1 mb/d drop from Iraq when the two nations subsequently went to war in 1980. In response to these supply disruptions, the real price of crude oil increased 81.1% (logarithmically) between January 1979 and the peak in April 1980. If we assumed a unit income elasticity, one would have

> expected oil consumption to have risen by 5.4% rather than declined by 16%, for a net decrease in quantity demanded of 21.4% and an implied intermediate-run price elasticity of
>
> $$\frac{\Delta \ln(Q)}{\Delta \ln(P)} = \frac{-0.214}{0.811} = -0.26$$
>
> consistent with the consensus estimates in Table 3[not provided in our project]. On the other hand, the relative price of oil increased 88% (logarithmically) between January 2002 and January 2007, despite which U.S. oil consumption actually increased 4.5% between 2002 and 2007. With U.S. real GDP growth of only 14.1% over this period, it is difficult to reach any conclusion other than that the price-elasticity of demand is even smaller now than it was in 1980. (17)

Also, Hamilton specifically references and endorses the Cooper figure for short-term PED of oil as provided in Table 1, as being within the expected range.

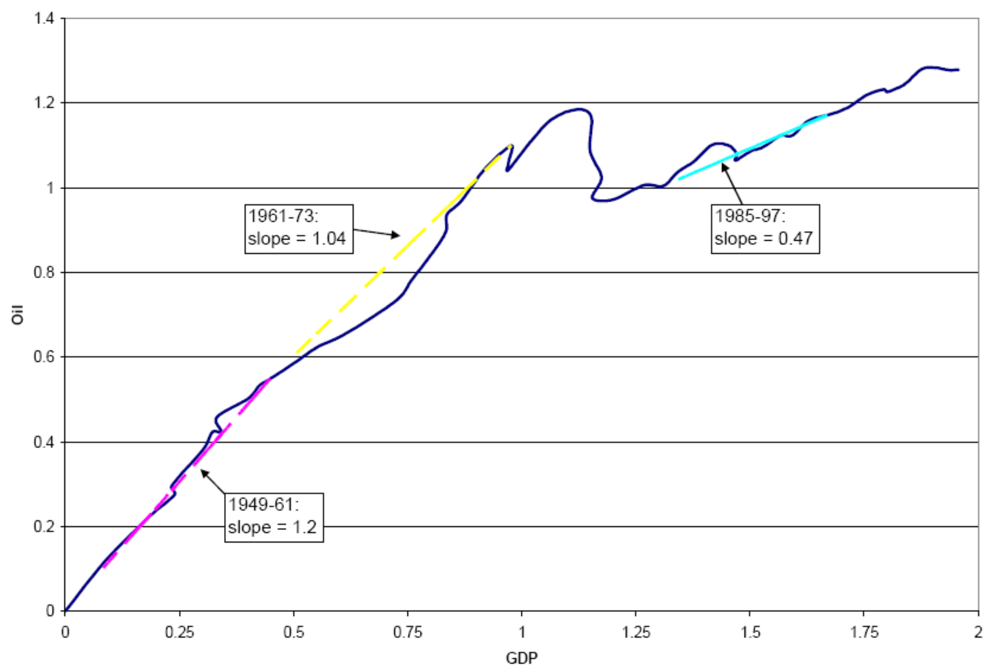

Figure 5. Changes in U.S. real GDP and oil consumption, 1949-2006. (From Hamilton 37)

However, even though the above-listed numbers for short-term PED are reasonable and accepted by economists, the figures are not definitive in providing a concrete basis for us to conduct our expected price-change calculations. The PEDs presented in Table 1 were calculated for indeterminate amounts of time and over a range of years from the 1970s up through the 2000s. In considering the passage of time, the PED results reported in the referenced literature are not applicable to the market situation faced today or even in the recent past. Moreover, we could not determine in every case the markets for which the PED was calculated. Were they based on markets in Europe, Asia, or the world? We simply don't know. Consequently, we chose to calculate our own short-term PED for oil based upon trading volumes within the United States market for the years 2006, 2007, and the first nine months of 2008. This effort provides more modern and accurate figures for us to base our finding and recommendations. We calculated a PED for each month of data reviewed. Next, with this specific figure for one month's PED, we assumed this number would not change during that given month. Therefore even when we added in DoD's bbl usage to simulate likely outcomes had DoD participated in the oil futures market during the time period examined, we held our previously calculated PED figure constant because we do not foresee an appreciable change in the PED value if the calculations were conducted any other way.

2. Calculations for Expected Price Change

Before presenting our results, we explain the calculations computed in arriving at those results using examples. The examples provided are calculations conducted with data from February 2006.

- First, we calculated short-term PED for the United States market traded through NYMEX. Figures used to calculate the percent change in price and quantity were taken from the previous month's data and the current month of concern. In our particular example for February 2006, our variables are defined as follows (Q is in thousands):
    - P_0 = Spot Price for last day of January 2006 ($65.49)
    - P_1 = Spot Price for last day of February 2006 ($61.63)
    - Q_0 = Quantity bbls oil traded January 2006 (1,006,771 bbls)
    - Q_1 = Quantity bbls oil traded February 2006 (1,027,355 bbls)
    - E_d = Short-term Price Elasticity of Demand

- Using the equations described in Section B.3 above, we calculated the % Change in Price, $\%\Delta P_0$ as:

$$\frac{61.63 - 65.49}{65.49} = -.0589$$

- We then calculated the % Change in Quantity, $\%\Delta Q_0$ as:

$$\frac{1{,}027{,}355 - 1{,}006{,}771}{1{,}006{,}771} = .0204$$

- Finally, PED, E_d is calculated:

$$\frac{.0204}{-.0589} = -.347$$

- Second, we calculated a new percent change in quantity demanded, $\%\Delta Q_1$ based upon the volume of bbls traded on NYMEX during February 2006 plus the number of bbls purchased by DoD during the same month. For this calculation, we assumed that DoD would hedge 100 percent of its fuel needs. We chose to base our calculations on a 100 percent hedge because we wanted to determine how a "worst-case" scenario, where all of DoD's fuel consumption was purchased in the futures market, would impact price. Variables assigned are as follows (Q is in thousands):
  - Q_2 = Quantity bbls oil traded February 2006 (1,027,355 bbls)
  - Q_3 = Quantity bbls oil purchased by DoD February 2006 (9,729 bbls)
  - Q_4 = Sum of Q_3 and Q_4 (1,037,084 bbls)
  - For this calculation, since we are interested in the $\%\Delta Q$ between Q_2 and Q_4 as described above,$\%\Delta Q_1$ is calculated as:

$$\frac{1{,}037{,}084 - 1{,}027{,}355}{1{,}027{,}355} = .0095$$

- Third, we algebraically calculate the expected, percent change in price, $\%\Delta P_1$, which would have existed if DoD had made oil purchases on the futures market. Three variables are involved with the equation. Values for two of them are known and we simply solve for the unknown. In this case, the calculation is based on E_d, which was calculated in step one and is being held constant and $\%\Delta Q_1$, which was calculated in step two. Variables assigned are as follows:
  - E_d = Price Elasticity of Demand (-.347)
  - $\%\Delta Q_1$ = Percent Change in Quantity Demanded (.0095%)

- $\%\Delta P_1$ is calculated:

$$\frac{.0095}{\%\Delta P_1} = -.347 \rightarrow (-.347)*\%\Delta P_1 = .0095 \rightarrow$$

$$\%\Delta P_1 = \frac{.0095}{-.347} = -.0273\%$$

- Fourth, the calculated value for $\%\Delta P_1$ is used to calculate the expected, new price per bbl of oil if DoD had purchased on NYMEX during a given month. This calculation provides a figure for the estimated impact and resulting price change for a 100 percent, DoD futures fuel purchasing program.
  - Therefore, in the case of our example for February 2006, the calculation is as follows:

$$(1+ -\frac{.0273}{100})*(\$61.63) = \$61.65 \rightarrow \text{which reflects a .02 cent change.}$$

Lastly, we calculated a weighted-average PED for the twelve months for each of the two years and the nine months of 2008. We did this to show what the yearly average would likely produce. Weights used were determined by dividing the bbl volume traded on NYMEX in a given month by the total volume traded for the year. This result produced a percentage that was used to allocate that percentage of the PED that was calculated for that particular month, to the overall weighted-average PED calculated for the year. These weighted averages were simply summed to produce the average for the year. The weighted-average PED was not used in any other calculations thus, we have suppressed example calculations showing how it was calculated. The results of the above-described calculations are provided in Table 2.

3. Calculations

For this portion of our analysis, we evaluated data over the chosen time periods to show, through calculations, the potential costs savings or losses that DoD could have realized if it had practiced hedging during that time. The data concerning futures transactions were collected from the EconStats.com website and all DoD fuel-price figures were provided by DESC. All prices used in our calculations are in United States dollars at nominal value for the given calendar month and year. However, the final results of the described calculations were adjusted for inflationary effects using the Producer Price Index (PPI) figures for "fuels and related products and power," which were published by the Bureau of Labor Statistics. We chose to use the PPI over any other index as we felt it appropriate because it takes into account inflationary effects on products at the initial stages of production/consumption rather than at the point of being finished goods purchased by an everyday consumer. Furthermore, the specific "fuels and related products and power" index is even more focused with concern to our project because it captures the price volatility for oil. Our figures were adjusted to reflect base year, 2008 dollars and were used to calculate the net gain or loss DoD could have realized from 2006 to 2008. Our table of results, Table 4, reflects these adjustments and reports the nominal figures as well.

Our first simulation was conducted assuming that DoD would purchase 70 percent of its annual fuel requirements in the futures market and purchase the remaining 30 percent in the spot market. We chose to simulate this hedging strategy as a starting point because our research revealed that Southwest Airlines has successfully employed a 70 percent hedging strategy in recent years. Furthermore, for simplicity and in line with realistic, bureaucratic processing, we assumed that DoD would use a 12-month hedge and repeat the process at the beginning of each successive year. The final assumption we made was that all of DoD's annual fuel requirements were purchased in January of the given CY. For illustrative purposes, we followed our first simulation with a second simulation which illustrates potential results from a 70 percent, futures-market purchase combined with a 30 percent, spot-market purchase, but over a six month time frame. Therefore, the second simulation assumes that DoD would make its fuel purchases during two different times in that year.

Month	Volume Traded (bbls)	DoD Volume Purchased (bbls)	Spot Price ($)	%ΔQ_0	%ΔP_0	E_d	Weight	Sum Product	%ΔQ_1	Total Volume w/ DoD Purchases (bbls) (Q_4)	DoD Market Share %	%ΔP_1	Δ Price per bbl ($)	Price Volitility ($)
PED and Expected Change in Price Calculations														
CY 2006														
Jan	1,006,771,000	10,949,000	65.49											
Feb	1,027,355,000	9,729,000	61.63	2.04%	-5.89%	-0.347	0.0913	-0.032	0.95%	1,037,084,000	0.94%	-0.03	-0.02	0.02
Mar	1,028,796,000	9,272,000	62.69	0.14%	1.72%	0.082	0.0914	0.007	0.90%	1,038,068,000	0.89%	0.11	0.07	0.07
Apr	1,035,548,000	11,248,000	69.44	0.66%	10.77%	0.061	0.0920	0.006	1.09%	1,046,796,000	1.07%	0.18	0.12	0.12
May	1,029,235,000	9,352,000	70.84	-0.61%	2.02%	-0.302	0.0914	-0.028	0.91%	1,038,587,000	0.90%	-0.03	-0.02	0.02
Jun	1,024,582,000	9,746,000	70.95	-0.45%	0.16%	-2.911	0.0910	-0.265	0.95%	1,034,328,000	0.94%	0.00	0.00	0.00
Jul	1,019,389,000	11,898,000	74.41	-0.51%	4.88%	-0.104	0.0905	-0.009	1.17%	1,031,287,000	1.15%	-0.11	-0.08	0.08
Aug	1,020,691,000	14,149,000	73.04	0.13%	-1.84%	-0.069	0.0907	-0.006	1.39%	1,034,840,000	1.37%	-0.20	-0.15	0.15
Sep	1,020,557,000	10,196,000	63.80	-0.01%	-12.65%	0.001	0.0907	0.000	1.00%	1,030,753,000	0.99%	9.63	6.14	6.14
Oct	1,027,920,000	9,696,000	58.89	0.72%	-7.70%	-0.094	0.0913	-0.009	0.94%	1,037,616,000	0.93%	-0.10	-0.06	0.06
Nov	1,023,105,000	9,475,000	59.08	-0.47%	0.32%	-1.452	0.0909	-0.132	0.93%	1,032,580,000	0.92%	-0.01	0.00	0.00
Dec	1,000,881,000	10,097,000	61.96	-2.17%	4.87%	-0.446	0.0889	-0.040	1.01%	1,010,978,000	1.00%	-0.02	-0.01	0.01
Total bbls:	11,258,059,000				**Weighted Average E_d**			-0.507			**Average Volitility for Year:**			$0.61
CY 2007														
Jan	1,013,154,000	10,377,000	54.51	1.23%	-12.02%	-0.102	0.083	-0.008	1.02%	1,023,531,000	1.01%	-0.10	-0.05	0.05
Feb	1,006,176,000	9,948,000	59.28	-0.69%	8.75%	-0.079	0.083	-0.007	0.99%	1,016,124,000	0.98%	-0.13	-0.07	0.07
Mar	1,019,477,000	11,496,000	60.44	1.32%	1.96%	0.676	0.084	0.057	1.13%	1,030,973,000	1.12%	0.02	0.01	0.01
Apr	1,031,363,000	10,302,000	63.98	1.17%	5.86%	0.199	0.085	0.017	1.00%	1,041,665,000	0.99%	0.05	0.03	0.03
May	1,043,577,000	11,230,000	63.45	1.18%	-0.83%	-1.430	0.086	-0.122	1.08%	1,054,807,000	1.06%	-0.01	0.00	0.00
Jun	1,044,341,000	11,396,000	67.49	0.07%	6.37%	0.011	0.086	0.001	1.09%	1,055,737,000	1.08%	0.95	0.64	0.64
Jul	1,026,994,000	11,713,000	74.12	-1.66%	9.82%	-0.169	0.084	-0.014	1.14%	1,038,707,000	1.13%	-0.07	-0.05	0.05
Aug	1,010,976,000	9,521,000	72.36	-1.56%	-2.37%	0.657	0.083	0.055	0.94%	1,020,497,000	0.93%	0.01	0.01	0.01
Sep	1,003,915,000	13,935,000	79.91	-0.70%	10.43%	-0.067	0.082	-0.006	1.39%	1,017,850,000	1.37%	-0.21	-0.17	0.17
Oct	1,001,368,000	10,113,000	85.80	-0.25%	7.37%	-0.034	0.082	-0.003	1.01%	1,011,481,000	1.00%	-0.29	-0.25	0.25
Nov	995,028,000	9,220,000	94.77	-0.63%	10.45%	-0.061	0.082	-0.005	0.93%	1,004,248,000	0.92%	-0.15	-0.15	0.15
Dec	983,046,000	10,666,000	91.69	-1.20%	-3.25%	0.371	0.081	0.030	1.08%	993,712,000	1.07%	0.03	0.03	0.03
Total bbls:	12,179,415,000				**Weighted Average E_d**			-0.006			**Average Volitility for Year:**			$0.12
CY 2008														
Jan	994,771,000	11,037,000	92.97	1.19%	1.40%	0.854	0.110	0.094	1.11%	1,005,808,000.00	1.10%	0.01	0.01	0.01
Feb	1,000,356,000	9,253,000	95.39	0.56%	2.60%	0.216	0.111	0.024	0.92%	1,009,609,000.00	0.92%	0.04	0.04	0.04
Mar	1,013,454,000	10,039,000	105.45	1.31%	10.55%	0.124	0.112	0.014	0.99%	1,023,493,000.00	0.98%	0.08	0.08	0.08
Apr	1,020,282,000	10,582,000	112.58	0.67%	6.76%	0.100	0.113	0.011	1.04%	1,030,864,000.00	1.03%	0.10	0.12	0.12
May	1,007,024,000	9,840,000	125.40	-1.30%	11.39%	-0.114	0.111	-0.013	0.98%	1,016,864,000.00	0.97%	-0.09	-0.11	0.11
Jun	1,000,696,000	11,078,000	133.88	-0.63%	6.76%	-0.093	0.111	-0.010	1.11%	1,011,774,000.00	1.09%	-0.12	-0.16	0.16
Jul	1,001,740,000	12,294,000	133.37	0.10%	-0.38%	-0.274	0.111	-0.030	1.23%	1,014,034,000.00	1.21%	-0.04	-0.06	0.06
Aug	1,008,724,000	11,662,000	116.67	0.70%	-12.52%	-0.056	0.111	-0.006	1.16%	1,020,386,000.00	1.14%	-0.21	-0.24	0.24
Sep	1,005,736,000	12,306,000	104.11	-0.30%	-10.77%	0.028	0.111	0.003	1.22%	1,018,042,000.00	1.21%	0.44	0.46	0.46
Total bbls:	9,052,783,000				**Weighted Average E_d**			0.086			**Average Volitility for Year:**			$0.14

Table 2. PED and Expected Change in Price Calculations for CY 2006-2008. Reported $ figures are nominal values. Raw data for NYMEX trades from EconStats.com and DoD data supplied by DESC.

For our successive simulations, we reverted back to a 12 month, futures-market hedge and examined a 30 percent to 70 percent, 50 percent to 50 percent, and 90 percent to 10 percent futures-to-spot purchases (respectively), strategy. We provided a wide variety of simulation examples in order to be objective in providing support for our assumptions. We felt that providing examples of a multitude of possible hedging combinations was the best way to highlight the fact that outcomes of a hedging program are dependent on the right combination designed to achieve a desired effect. Furthermore, we wanted to roughly determine at what dollar amount and volume; DoD would have needed to purchased its fuel in the futures market to have saved money during CYs 2006-2008. Following our explanation and example calculations, we provide in Table 3, a summary of futures prices, spot prices, volume and prices for purchased by DoD over the years examined.

For the time period January 2006 through January 2007, we calculated the total cost of DoD's spot-market purchases and futures-market purchases. The following bullets detail mathematical computations conducted:

- Total Cost for Spot Price Purchases = 30%*(Total bbls of fuel purchased by DoD in 2006)*(Spot price January 2006)
- Total Cost for Futures Price Purchases = 70%*(Total bbls of fuel purchased by DoD in 2006)*(12 month futures price January 2006)

We then added the results from the above calculations together to arrive at a total DoD fuel cost in 2006 under a 70 percent hedging program.

In the next step, we looked at the amount of money DoD could have saved or lost by participating in the futures market. To calculate this figure, we subtracted the January 2007 spot price from the 12 month, January 2006 futures price and multiplied this times 70 percent of the volume (bbls) of fuel purchased by DoD in 2006. For example:

- 70%*(125,807,000 bbls)*($54.51 - $70.69) = $ -1,424,890,082.00

Unfortunately in this example, this figure represents the dollars lost by DoD in purchasing 70 percent of its fuel for the year at the $70.69 futures price in January of 2006 vice waiting and purchasing this quantity at the spot price of $54.51 in January 2007.

Pricing and DoD Purchase Volume Data						
Month	Spot Price ($)	6 Month Futurers Price ($)	12 Month Futurers Price ($)	DoD Price ($)	% Mark-up from spot pirce to DoD Price	DoD Volume (bbls)
CY 2006						
Jan	65.49	69.70	70.69	78.09	19.24%	10,949,000
Feb	61.63	64.83	67.08	76.69	24.44%	9,729,000
Mar	62.69	69.09	69.80	83.01	32.41%	9,272,000
Apr	69.44	74.75	75.43	81.06	16.73%	11,248,000
May	70.84	72.89	74.39	93.76	32.35%	9,352,000
Jun	70.95	76.00	76.44	93.59	31.91%	9,746,000
Jul	74.41	76.47	78.38	93.13	25.16%	11,898,000
Aug	73.04	73.02	75.16	93.28	27.71%	14,149,000
Sep	63.80	65.83	68.41	89.79	40.74%	10,196,000
Oct	58.89	62.90	66.05	83.01	40.96%	9,696,000
Nov	59.08	66.27	68.87	79.41	34.41%	9,475,000
Dec	61.96	63.95	66.53	84.59	36.52%	10,097,000
CY 2007						
Jan	54.51	60.14	62.65	81.48	49.48%	10,377,000
Feb	59.28	64.70	67.16	78.60	32.59%	9,948,000
Mar	60.44	68.73	69.89	79.20	31.04%	11,496,000
Apr	63.98	68.10	71.22	85.45	33.56%	10,302,000
May	63.45	65.83	68.69	88.38	39.29%	11,230,000
Jun	67.49	71.06	72.10	91.69	35.86%	11,396,000
Jul	74.12	76.82	73.94	91.46	23.39%	11,713,000
Aug	72.36	71.83	70.29	96.52	33.39%	9,521,000
Sep	79.91	79.58	76.55	96.64	20.94%	13,935,000
Oct	85.80	92.14	87.53	104.38	21.66%	10,113,000
Nov	94.77	87.43	85.49	110.92	17.04%	9,220,000
Dec	91.69	94.65	91.44	112.52	22.72%	10,666,000
CY 2008						
Jan	92.97	90.33	89.15	112.68	21.20%	11,037,000
Feb	95.39	100.97	99.49	113.52	19.01%	9,253,000
Mar	105.45	100.08	97.54	128.44	21.80%	10,039,000
Apr	112.58	111.32	108.39	139.84	24.21%	10,582,000
May	125.40	126.62	125.76	154.75	23.41%	9,840,000
Jun	133.88	141.24	141.30	171.91	28.41%	11,078,000
Jul	133.37	125.29	125.08	171.36	28.48%	12,294,000
Aug	116.67	116.68	117.48	160.37	37.46%	11,662,000
Sep	104.11	100.80	102.54	150.23	44.30%	12,306,000
Oct	76.61	69.92	73.28			
Nov	57.31	58.24	63.78			
Dec	41.12	51.96	57.93			
			Average Price Δ from Spot to DoD:			**29.45%**

Table 3. Pricing and DoD Purchase Volumes for CY 2006-2008. Reported $ figures are nominal values. Raw data for NYMEX trades from EconStats.com and DoD data supplied by DESC.

Following the above calculation, we then calculated the savings or additional costs realized by DoD caused by the change in the spot price from January 2006 to January 2007. This computation was accomplished by subtracting the January 2007 spot price from the January 2006 spot price and multiplying this result times 30 percent of the total volume of fuel purchased by DoD in 2006. For example:

- 30%*(125,807,000 bbls)*($65.49 - $54.51) = $ 414,408,258.00

This result represents the savings that DoD realized because the price of fuel in the spot market decreased from $65.49 to $54.51.

Finally, having calculated the two-separate results for expected savings/loss for DoD's hedged and unhedged volumes of fuel, we then added the figures, $414,408,258.00 and $-1,424,890,082.00 to arrive at the result, $-1,010,481,824.00, which represents the amount of money DoD would have lost by using a 70 percent hedging program during CY 2006-2007.

We then repeated the same above-described calculations for January 2007 to January 2008 and arrived at a savings of $1,258,376,062.00. Finally, we added the total loss from 2006-2007 ($-1,010,481,824.00) to the savings realized from 2007-2008 ($1,258,376,062.00) and arrived at a net savings of $247,894,238.00 for DoD's budget if it had used a 70 percent fuel hedging program that spanned across the analyzed years. Table 4 presents a comprehensive summary of our computational results.

4. Conclusion

This chapter presented and analyzed quantitative data regarding oil purchases made through a hedging program. First, we calculated the PED for the U.S. futures market for oil over a selected time period. Most of the results of this process were within range of expectations. We expected each PED calculated would be .1 or less, but we did realize a few results outside that range for a few on the individual months for which PED was calculated. These outliers are explained through evaluation of the relationship between $\%\Delta Q$ and the $\%\Delta P$. Drastic differences between either one of these variables causes extreme results for PED. In each case of the outliers, the rate of change between the two variables was enough to cause the overall result to be outside the expected range. The weighted average PED across the three years evaluated ranged from -.006 to .086 which means the PED for oil is inelastic. This simply means that as the price of oil increases by 1 percent, the quantity demanded decreased by .006 percent or as the price of oil decreased by 1 percent, the quantity demanded increased .086 percent across the range.

Next, based on historical DoD fuel purchases, we took the PED results and calculated an expected $\%\Delta P_1$ for the per bbl price for oil on the futures market if DoD made its oil purchases on that market. We feel this calculation to be the most important of all our calculations because it provides the expected price in relation to DoD's purchase volume which averages to 10,721,667 bbls per month over the time period evaluated. Interestingly, the price-change effect is very low and even negative in some instances. These results indicate that DoD purchases on the futures market would not have had a drastic price effect on the market price. As in any analysis, we did realize one significant outlier where the $\%\Delta P_1$ was equal to 9.63 percent. This outlier was an uncharacteristic anomaly, which is explained because the associated PED was .001. All remaining values for $\%\Delta P_1$ were under 1 percent.

The last major set of calculations conducted was done to simulate the outcome if DoD had practiced a mixed hedging strategy over the three-year period. We simulated a variety of strategies over two different time frames. The results from this process were to simply show the expected savings or loss DoD may have experienced over that time frame. Results from this computation were encouraging as well.

Detailed analysis of our results and what they mean to our project is presented in the following chapter.

Time Period	Strategy	Spot Purchases ($)	Futures Purchases ($)	Total Expended ($)	Futures Market Savings/Loss ($)	Cash Market Savings/Loss ($)	Net Gain/Loss ($)	2008 Real Value ($)
Jan 2006 – Jan 2007	12 month 70% Futures 30% Spot	2,471,730,129	6,225,307,781	8,697,037,910	-1,424,890,082	414,408,258	-1,010,481,824	-909,933,262
Jan 2007 – Jan 2008		2,124,532,701	5,697,510,035	7,822,042,736	2,757,358,408	-1,498,982,346	1,258,376,062	951,949,077
Total Potential Savings/Loss from January 2006 – September 2008 : $247,894,238.00								$42,015,815
Jan 2006 – Jan 2007	6 month 70% Futures 30% Spot	1,184,635,512	2,941,841,840	4,126,477,352	52,759,000	-98,764,848	-46,005,848	-41,428,010
Jan 2007 – Jan 2008		1,058,840,397	2,725,803,402	3,784,643,799	333,133,605	-252,132,606	81,000,999	61,276,457
Total Potential Savings/Loss from January 2006 – September 2008: $34,995,151								$19,848,447
Jan 2006 – Jan 2007	12 month 30% Futures 70% Spot	5,767,370,301	2,667,989,049	8,435,359,350	610,667,178	966,952,602	356,285,424	320,833,043
Jan 2007 – Jan 2008		4,957,242,969	2,441,790,015	7,399,032,984	1,181,725,032	-3,497,625,474	-2,315,900,442	-1,751,955,838
Total Potential Savings/Loss from January 2006 – September 2008: $-1,959,615,018								$-1,431,122,795
Jan 2006 – Jan 2007	12 month 50% Futures 50% Spot	4,119,550,215	4,446,648,415	8,566,198,630	-1,017,778,630	690,680,430	-327,098,200	-294,550,110
Jan 2007 – Jan 2008		3,540,887,835	4,069,650,025	7,610,537,860	1,969,541,720	-2,498,303,910	-528,762,190	-400,003,381
Total Potential Savings/Loss from January 2006 – September 2008: $-855,860,390								$-694,553,491
Jan 2006 – Jan 2007	12 month 90% Futures 10% Spot	823,910,043	8,003,967,147	8,827,877,190	-1,832,001,534	138,136,086	-1,693,865,448	-1,525,316,414
Jan 2007 – Jan 2008		708,177,567	7,325,370,045	8,033,547,612	3,545,175,096	-499,660,782	3,045,514,314	2,303,901,535
Total Potential Savings/Loss from January 2006 – September 2008: $1,351,648,866								$778,585,121

Table 4. Calculation Results Highlighting Possible Outcomes in Various DoD Hedging Scenarios.

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V. CONCLUSION

A. FINDINGS

Currently, there is no clear solution or consensus as to how DoD should address its fuel procurement concerns. As a result, we examined this important issue from a market impact, fuel-cost and risk-reduction perspective. The problem was specifically reviewed in two dimensions—first, this study explored whether DoD could have hedged against fuel-cost risks by making purchases on the commercial futures market for oil without causing significant disruptions to the market. Second, we identified how substantial DoD savings or losses may have been if the Department had practiced a hedging program over the time periods evaluated.

Our first research question was: Would DoD disrupt market prices as a result of buying its fuel requirements in the futures market? On initial assumption, due to the large volume of fuel consumed by DoD each year, many believe that DoD’s trading in the futures market would likely overwhelm the market by putting upward pressure on the per bbl price for oil. As highlighted in Table 2, located in Chapter IV, with all other variables held constant, DoD participation in the market only had a net impact of 29 cents on the price per bbl of oil, on average per year. Further, the overall impact of DoD trading was calculated for a “worst-case” scenario and is thus overstated in our evaluation. Our PED findings reflect an example where DoD would purchase all of its fuel requirements in the futures market which is an unrealistic and not recommended practice because it takes on a great amount of risk. We merely used this scenario as an illustrative example. Our analysis shows that the value of that result, caused by DoD’s participation in the commercial, futures market would likely be negligible.

Additionally, we found on average, DoD’s fuel requirements make up less than 1 percent of the total volume traded on the futures market in any given year. This means that DoD's normal purchases are not large enough to have a drastic effect on the market price for a bbl of oil. Intuitively, a less-aggressive, fuel-hedging program whereby DoD would purchase less than 100 percent of its requirements on the futures market would have an even smaller impact on trading prices.

Our second research question was to determine the savings or losses had DoD practiced a hedging program during the years studied. To answer this question, we calculated likely outcomes for a wide variety of hedging plans that combined different ratios of purchases on the futures and spot markets across two different time periods. In a hypothetical 70 percent futures purchases and 30 percent spot purchases fuel hedging program for both a six and twelve-month time frame, our findings show an unadjusted savings to DoD of $34,995,151 and $247,894,238 respectively. Additionally, we calculated an unadjusted savings of $1,351,648,866 from a 90 percent futures, 10 percent spot purchases hedging scenario using 12-month, futures contracts. While the 90 percent futures purchases and 10 percent spot purchases program is probably too aggressive for DoD, the results of such a scenario indicates the dramatic savings possibilities a hedging program could offer. Although the unrealized savings are only in the millions of dollars and small in comparison to DoD's overall budget (less than 1 percent), these savings are significant enough to warrant changes in DoD's fuel procurement process.

B. RECOMMENDATIONS

Currently, because of the way budget authority is handed down from Congress, DoD lacks the legislative authority to establish a hedging program where it could trade on the commercial futures market. The details surrounding such restrictions are beyond the scope of this project, but the fact that DoD currently has no authority to hedge fuel purchases means that there must be policy changes adopted before our recommendations could be implemented.

Our recommendation is for DoD to implement a strategy for purchasing its oil requirements with a 70 percent futures and 30 percent spot, 12-month, futures hedging program. This ratio provides a good balance to meet DoD's need while being flexible enough to assure DoD is not over hedged to the point where it is assuming more risk in an already volatile market. The scenario we conducted under this strategy yielded an unadjusted savings of $247,894,238.00 over a three-year time period. Of course, actual yield could be more or less.

In closing, hedging is not a 100 percent solution to DoD's budget problems associated with rising fuel prices. However, we do believe that a hedging program could provide substantial relief. There are many lessons to be learned from the airline industry that DoD could adopt and incorporate into its own cost-saving plan. With a hedging program, DoD would essentially be able to reduce the impacts of oil price volatility, develop a more stable and consistent budget, and pass the benefits along to its customers within DoD. Granted, the potential savings highlighted in this project were not net of hedging cost, but we feel these cost to be likely negligible in comparison to the savings yield. Ultimately, cost savings realized by DoD could be used for other critical programs or requirements and further heighten our national defense readiness.

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